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EDUCATIONAL HYGIENE

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EDITOR'S INTRODUCTION

The World War, with its tremendous human as well as material losses, gave a new impetus to health work and to health teaching in the schools, not only in the United States, but all over Europe as well. In our country, much of the misguided opposition to a health program in the schools that had disturbed us before 1914 has since been silenced, and progress in health work and health teaching will be made now in a decade that probably would not have been made in twice that time had the War not taken place. Health leagues and clubs have been formed generally among the pupils in our schools. The Junior Red Cross, Scouts, and similar organizations have grown rapidly in membership and influence, health codes for children have been formulated and enforced by the young people themselves, health clinics have been organized and supported, safety and first-aid education have been given a new significance, "better health weeks" have been planned and observed, the school nurse and health and development work have been added to a large number of school systems, school feeding has been established, and extensive community-health programs have been instituted and carried through. Still more, many excellent health readers and elementary textbooks on health have been prepared for use by school children, and adapted to work in almost all the grades, while courses in health teaching have been added to the outline of instruction for nearly all our school systems. We might almost say that the new health program, so far as public education has been concerned, has been concentrated largely on the children in our schools, with some extension

into the homes through the nurses, visiting teachers, and the children themselves.

For the teachers who are called upon to direct this new health work in the schools, on the contrary, but little in the way of training for the work has as yet been undertaken. They have largely been expected to make bricks without straw. In the normal schools and colleges where teachers are trained, some instruction in community hygiene and sanitation has here and there been introduced, with some work in child hygiene, but no general and directed attempt has as yet been made to train all teachers for effective health teaching. We have merely repeated here the history of the earlier nature-study movement, when books containing all kinds of scientific information were prepared for children, but the teachers in the schools remained largely unable to do effective scientific teaching because their training had included little or no science.

What has been needed for health teaching, for some time, has been a good general textbook for study by teachers, that they might be better prepared to handle a health program, in all its aspects, in the schools. Within the past decade a number of good texts have been issued which have dealt with single phases of the hygiene movement, of which Terman's *Hygiene of the School Child* was a pioneer and is still of fundamental importance, but up to now we have lacked a general textbook for teachers which would, in the compass of a single volume, give them the essentials of what they need to know about the different aspects of the new health-teaching movement — child hygiene, school hygiene, personal hygiene, community hygiene, mental hygiene, and the pedagogy of hygiene.

This lack the author of the present volume has aimed to supply, and in doing so he offers us a basis for a solid and substantial course for teachers in training in normal schools

and colleges, one that will give them a solid basis for health and hygiene teaching in the schools. Such a course in a teacher-training institution is of far more importance in the training of prospective teachers than a course in the pedagogy of arithmetic or grammar or a course in general methods, important as these may be, because the formation of good health habits, based on a sound knowledge of the human mechanism and the importance of good health, is fundamental to proper living and intelligent citizenship. The volume is interestingly written, well illustrated, accurate in its scientific knowledge, and constructive in its proposals for procedures in teaching. Any teacher, whether in training or in service, who studies this book carefully can scarcely help becoming a better and a more intelligent teacher of health and physical development work in our schools.

ELLWOOD P. CUBBERLEY

AUTHOR'S PREFACE

WITHIN recent years there has been perhaps no subject of study pursued in teacher-training institutions more vitally in need of a new orientation and a changed emphasis than that of hygiene. The World War has been responsible for demonstrating to us the existence of a disturbing lack of vigorous health and stamina in our people, and has served to throw into new relief the emphatic need of building into the lives of our youth, while they are still children in the schools, those indispensable habits and attitudes of healthy living that can alone be relied upon to raise up for us a generation of reasonably robust and healthy men and women.

If this ideal is happily to be accomplished, the training which the teachers receive in the time-honored but somewhat moss-grown subject of educational hygiene will have to be very sharply and definitely modified. The prime reason back of the mediocre estate which the teaching of hygiene in the lower schools has always occupied has lain in the circumstance that the teachers have not themselves understood the real significance of health teaching, have not been trained to teach health as a vital and an absorbing subject, and have been responsible for passing on to children the same attitude of indifference that they have themselves been unable to shake off.

In consequence of this unfortunate state of affairs, for which the training schools have been themselves in a measure guilty, the teaching of hygiene has, until somewhat recently, failed signally and almost universally in our schools to capture the interest, and in many cases even to inspire the respect, of the pupils who are required by the program to

submit to periodic doses of it from uninteresting texts in physiology and anatomy, administered by a none too sympathetic and interested teacher. Within the last decade there has been good evidence, if one may judge from the considerable number of excellent juvenile texts that have appeared, that the teaching of hygiene is shortly to have a rebirth in the schools, and that the subject can be made not only highly interesting but of inestimable value to the pupils in aiding and inspiring them to lay the foundations for a healthful and satisfying life.

Thus far, however, the texts in educational hygiene available for our teacher training institutions have been less numerous. They have also in most cases been limited in scope to certain specific fields or divisions of the subject. The proper scope of educational hygiene comprises child hygiene, school hygiene, personal hygiene, community hygiene, mental hygiene, physical education, and the pedagogy of hygiene. Writers of texts have felt it necessary in most cases to confine themselves to one or two of these departments of hygiene, with the result that few books are as yet available which may be made the basis for a composite course for teachers in training or in service.

It has been the aim of the author of this volume to include within its pages sufficient material in all these divisions of educational hygiene to form a satisfactory basis for a complete course for students in this subject. To this end, the references have been selected with great care in the belief that, if they are carefully and faithfully investigated, they will furnish, together with the author's text, a satisfactory and reasonably complete survey of the entire field of educational hygiene. The emphasis throughout the volume has been upon the teaching side, and while the author has felt it necessary to provide a structural approach to several of the chapters dealing with personal hygiene, his chief concern has

been, first, to stress the importance of health; and second, the teaching of health to children. He is, of course, aware of numerous shortcomings, and some rather glaring omissions; the latter, however, appear to him unavoidable in a volume which aims to cover the extensive ground which the present one does.

LAWRENCE A. AVERILL

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A Reference Library for Supplementary Use in Connection with This Volume

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CONTENTS

EDUCATIONAL HYGIENE

CHAPTER I

THE MEANING AND IMPORTANCE OF HEALTH

What is health? Of all the blessings of mankind, there can be no doubt that health is one of the most prized. Those of us who possess it in abundance rarely pause to consider the sad estate of those less fortunate who either have lost it or have never enjoyed it. It is well, therefore, at the very outset of our study of educational hygiene to seek to understand just what the significance of health is, and its supreme importance in the economy and happiness of life.

It is hardly necessary to attempt to define either health or disease: they are so commonly met with, and so universally, by all of us that we know well enough the characteristics of both. It may be helpful for our purpose in this volume, however, to posit as a working definition of health the following: *Health is that condition of body and mind in which sufficient energy is available for the performance of a full day's work and a full day's play — and that abundantly, without friction and without depletion.* With this standard of health as his emblem, and with the strength of character and purpose that properly and fittingly go with it, any individual should be adequately equipped to build a life and a work that will endure as long as the best. He is building upon a rock!

Seekers after health have always comprised the most pathetic companies of all those moving across the highways of life. Wearing upon their banners emblems of suffering,

and in their faces conflicting tokens, now of hope and now of despair, they have been shuffling across the stage of life continuously since those ancient and unchronicled days when disease and defectiveness first made their appearance in the bodies and minds of men. In every generation their number has been legion, and always there have been reënforcements from the rear as the privations and hardships of the way have taken their fell toll from those in the vanguard.

Naaman, the Syrian leper-king, sought healing at the hands of the prophet of Jehovah; the paralytic sought healing in the turbid pool of Bethesda; the suffering woman sought it from the garment of Jesus; romanticists and adventurers have sought it tirelessly from will-o'-the-wisp founts of eternal youth; worshipers have sought it in temples and shrines and in sacred groves, or have presumed to wrest it from deities of stone or wood or gold; some have sought it at resorts and watering-places in the West, the South, the East, the North; some have sought it in mountains, some at seasides; some in hospitals and sanatoria; others have sought it assiduously and credulously in abstention from or moderation in certain foods and drinks; thousands have sought it and are seeking it in dietary absurdities, like yeast-eating; thousands more in prescriptional absurdities, patent medicines and potions; millions are seeking it in the offices of physicians and on the tables of surgeons throughout the land.

What, then, is disease? We may characterize it as that condition of mind or body in which either there is no energy available for the performance of one's daily work — and of course none for play — or else the entire supply available is insufficient in amount for the daily withdrawal, thus involving serious friction and inevitable depletion. The architect who, either through ignorance and neglect or by virtue of inheritance, is doomed to hew out a life and a work under

the malign influence of this emblem is building upon the sand. His house must fall!

How many are healthy? One striking means which we have of forming a judgment concerning the extensiveness of ill-health and disease is afforded by the surprisingly large number of postponable deaths which occur annually in the United States. Professor Irving Fisher, the Yale economist, after indefatigable statistical analyses, concludes that forty-two per cent of the deaths which occur each year are preventable. That is to say, of the 1,500,000 persons who will die this year, 600,000 might continue to live and produce wealth for an indefinite period, if only they had intelligently observed the known rules of health and hygiene. Fisher estimates that fifteen years might be thus added to the average span of human life. Figuring the average loss to society from every preventable death at $1700, as Professor Fisher does, the actual gross monetary loss to the country yearly from such deaths reaches the enormous sum of $1,070,000,000. These estimates do not, of course, include the economic loss which in addition society sustains continuously from temporary illness, with the attendant losses in wages and production, which undoubtedly totals another billion of dollars a year. Nor do they take into account those human and personal aspects of disease and suffering that lower the efficiency and dull the spirit of the worker.

Another and more immediately striking basis for appreciating the extensiveness of ill-health and disease is afforded by an analysis of the findings of the Selective Service Act of 1917. Never before has our country attempted a comprehensive survey of the physical condition of her citizenry. At most, previous to 1917, only the results of limited samplings here and there by school medical men, insurance examiners, and practicing physicians were available. When the great national emergency came in 1917, however, a

thoroughgoing and far-reaching system of medical examination such as the country had never before undertaken, and which doubtless would not otherwise have been attempted in a generation, was set in operation. A gigantic organization numbering 4557 local draft boards, covering every town, village, and hamlet in the United States, was created and charged definitely with the responsibility of enrolling 10,000,000 young men and of certifying them physically as rapidly as they might be needed for military service.

The *First Report of the Provost Marshal General* to the Secretary of War (of December 20, 1917) presented the results of the examination by each of the 4557 local boards — as well as by the sixteen concentration camps — of 2,510,706 men between the ages of twenty-one and thirty-one years, as follows:

TABLE 1. SHOWING THE PERCENTAGE OF PHYSICAL REJECTIONS IN THE FIRST DRAFT (1917)

		PER CENT
Total number examined physically by local boards .	2,510,706	100.
Total number found physically qualified..........	1,779,950	70.89
Total number found physically disqualified........	730,756	29.11
Additional per cent rejected at the sixteen camps ..		4.00
Total per cent of all rejections on physical grounds.		33.11

The disconcerting conclusion is that almost exactly one third of the young men of America are in a condition of physical defectiveness which is sufficiently serious to make their admission into the armies of the Republic impossible.

It must be admitted, of course, that in the earlier drafts the standards of the army medical men were high and the supply of recruits in sight almost unlimited; hence only those in a prime condition of health were certified for service. Had the emergency developed to greater proportions, there is no question but that many of those rejected earlier would ultimately have been called. The fact remains, however,

that a third of the youth of the land were deemed seriously unsound physically, and were so recorded.

It is true also that an individual may enjoy a sufficient degree of health and vitality to perform his daily work as a civilian, and be at the same time below physical par from a military standpoint. After all, it might be urged, modern warfare requires in its battle-lines a superbness of vitality distinctly above and beyond the requirements of civil life. Its privations, its hardships, its demoralizing drain upon nerve and muscle, have no equivalents in the less arduous demands of the shop, the office, and the market-place.

TABLE 2. SHOWING THE TWELVE PRINCIPAL CAUSES OF DISQUALIFICATION FOR MILITARY SERVICES (1918) [1]

CAUSE	NO. REJECTED	PER CENT OF TOTAL REJECTIONS
All causes	467,694	100.
Heart and blood vessels	61,142	13.07
Bones and joints	57,744	12.35
Eyes	49,801	10.65
Respiratory (including tuberculosis)	48,356	10.34
Mental and nervous defects and disorders	48,242	10.31
Developmental defects (height, weight, chest measurement, muscles)	39,166	8.37
Hernia	28,268	6.04
Ears	20,465	4.38
Flatfoot	18,087	3.87
Teeth	14,793	3.16
Genito-urinary (including venereal)	12,544	2.68
Skin	12,519	2.68

[1] *Second Report of the Provost Marshal General* to the Secretary of War, pp. 165 ff. Washington, 1919.

The cost of disease. Notwithstanding all this, the contribution that exuberantly sound, healthy bodies would make to our industrial, business, and professional enterprise cannot be calculated. It is estimated that there are 3,000,000 people continuously on sick-beds in America. When we have made due allowance for the cases of unpre-

ventable or "normal" illness, there must still remain hundreds of thousands of people continuously ill largely from preventable causes.[1] Besides these 3,000,000 definitely though preventably ill people, there are unknown millions of others who are nominally well and are found daily in their places, but who are working at low pressure because of sapping and de-energizing forces at work in their organism that are exacting their wretched toll.

By far the most disconcerting thing about the results of the army examinations is the thwarted expectation that it should be in the twenties, after the biological storm and stress of adolescence have passed and before the effects of wear and tear begin to make their appearance, that the physical organism would be found at the peak of its efficiency and perfection. One should not be surprised to find deficiency in the unstable teens, nor yet in the middle forties and beyond. As it is, however, the conclusion is as unescapable as it is logical that it was neglect in the teens of some 730,000 conscripts that paved the way for their rejection in 1917. Nor is it unreasonable to infer that in considerable measure the inefficiency of middle life and the premature and postponable deaths are the perennial and inevitable outcome of this same neglect. Small wonder in Professor Fisher's contention that fifteen years could easily be added to the span of human life!

Disease is also expensive from a monetary standpoint. The Roosevelt Conservation Commission on National Vitality concluded that the financial loss due to incomes cut off by preventable disease and postponable death amounts to a billion and a half dollars annually. The fight against tuberculosis costs us $500,000,000 a year; typhoid fever costs

[1] The *Report of the Roosevelt Commission on National Vitality* concluded that one half of the 3,000,000 sick-beds constantly kept filled in the United States are unnecessary.

$200,000,000; malaria and hookworm, another $200,000,000; and so on decreasingly for the other maladies to which mankind falls constantly prey.

Table 3 summarizes some of the chief causes of death, in 1922, in the registration area[1] of the United States, and indicates the size of our annual death toll from these causes.

TABLE 3. SOME SIGNIFICANT MORTALITY STATISTICS FOR 1922

CAUSE OF DEATH		RATE PER 100,000	PER CENT OF TOTAL
All causes	1,101,863	1,181.7	100.
Diseases of the heart	154,495	165.7	14.
Influenza and pneumonia	124,441	133.5	11.3
Tuberculosis	90,452	97.	8.2
Nephritis	82,518	88.5	7.5
Cancer and malignant tumors	80,938	86.8	7.3
Cerebral hemorrhage and softening	80,191	86.	7.3
Congenital malformations and infantile diseases	72,940	78.2	6.6
Accidents	65,263	70.	5.9
Diarrhœa and enteritis	36,873	39.5	3.3
Arterial disease	20,826	22.3	1.9
Diabetes	17,182	18.4	1.6
Syphilis	15,360	16.5	1.4
Diphtheria	13,659	14.6	1.2
Appendicitis and typhlitis	13,229	14.2	1.2

The values of health. There are certain values of health that should not be overlooked.

1. *Health guarantees us the energy and strength required for the daily work.* Through his daily work, man wins his daily bread. His work may be in a shop or an office; in a labor crew or at a lathe; in skilled or unskilled occupations; in industry or in the professions: the *kind* of work is of small consequence. Through his productive toil he repays society for its investment in his early care and training, and receives

[1] The death registration area in 1922 comprised 37 States, the District of Columbia, and 13 cities in non-registration States, with an estimated population aggregating 85.3 per cent of that of the entire United States.

in return a wage more or less commensurate with his social worth. The first great and supremely important value of health is its contribution of general fitness to the body which renders it capable of performing work. The sound body finds no difficulty in executing its daily eight-hour run smoothly and without friction. It is not unlike a well-oiled, skillfully fired and mechanically perfect locomotive which pulls in at the terminal at the end of the day's run a bit grimy, it is true, but otherwise as sound and as fit as when it left its stall in the morning. Good health insures abundant motive power for the ordinary work of life.

2. *Health supplies the inclination and the energy to play.* Play is a biological as well as a psychological necessity to the normal person. Respiration, circulation, and alimentation — the great physiclogical trinity — depend for their quickening upon frequent and regular exercise in which are involved skill or deftness of muscle, moderate endurance under tension, and the consequent rapid metabolism of the tissues. The individual who limits his expenditure of energy to the bare requirements of his vocation is in all probability denying the fullest development to his neuro-muscular mechanism. Groomed, geared, and accoutered by nature for a limited, he who "throttles down" to accommodation speed need not be surprised to find his accumulating head of steam high and his safety valves dangerously near the blowing point. Only persons who enjoy a fine margin of good health have the energy to tone and temper their biological mechanisms by thus resorting regularly to vigorous and rejuvenating exercise and play.

But play is a psychological necessity, as well as a biological one. The mind of the normal person craves the excitement and enthusiasm of play in much the same way that his muscles crave the discharge of their stored-up energy. Man is a better worker, a better producer — a better citizen

— because of his play. Release of neuro-muscular energy under the enticing urge of the play spirit reacts salubriously upon his whole mental and moral nature. Attitudes of optimism, buoyant states of mind, agreeable and salutary points of view, are among the personal and social virtues which are contributed inevitably to the mind and spirit of man in the exercising place. And it is good health which again is the prime imparter of the inclination to, as it is of the energy for, play. The dyspeptic, the rheumatic, the tubercular, and the anæmic lack essentially both.

3. *Health lays the foundations for the largest human service.* The sick man is a poor servant of his fellows, notwithstanding the circumstance that in some well-known and often-cited instances physically weak and unhealthy individuals have rendered conspicuous and monumental service to the race. Such is not ordinarily the case. An unwell person is prone to devote too much of his scanty energy to the taking care of himself to have much time or strength available for wide service to others. The ideal of Williams,[1] "to live most and to serve best," is worthy of adoption as the goal of every individual who is anxious to keep his body strong and well in order to serve his family, his profession, and his community in the largest possible way.

4. *Health is an indispensable condition of personal attractiveness, charm, and vitality.* Some one has remarked pointedly that a nervous person never dies young, but that his friends usually do! Serenity, poise, and enthusiastic personality do not ordinarily radiate from a diseased person. An invalid is ordinarily a center of contagion for pessimism and distemper. Those virtues of personality which we find so captivating in our friends — optimism, exuberance, and the glow of life — emanate ordinarily from spirits that are not bound within the murky and forbidding confines of a

[1] Williams, J. F. *Personal Hygiene Applied,* chap. 1.

sick body. Thus intimately are states of mind and states of organism connected. If we would be buoyant, resilient, and vivacious, if we would have poise and magnetism, if we covet fullness of life and richness of influence, we shall seek first of all to preserve and maintain the highest achievable state of physical robustness: then indeed shall all these things of personality be added unto us.

5. *Good health makes for efficiency in our work.* One of the first questions asked by prospective employers of applicants for positions with them concerns the condition of health of the candidate. No one knows better than they the practical relationship between health and dollars and cents. No one knows better than they the economic loss in productivity and service sustained annually by the community from sickness and general ill-health among the workers. No one knows better the low efficiency and consequent low output of workers whose health has not been properly safeguarded, and who are not in proper physical condition to render first-rate service. The greatest wealth undoubtedly is health, not only from the standpoint of the individual but also from the standpoint of the industry or profession in which he engages, and of the society which, indirectly, he serves. It is of small consequence whether one be a worker with his hands or a worker with his brain, the essential contingency is the same: if an over-amount of energy must be deflected from the ordinary routine to the coddling and urging forward of an incompetent organism, the productivity invariably suffers sooner or later. From being an unobtrusive servant, the physical organism is in danger of becoming a querulous and exacting master.

6. *Our health in a large way conditions our happiness.* Where shall one look for a happy dyspeptic? Or for a contented diabetic? Or for a serene bronchitic? Surely for the hundreds who override and overrule the physical protests of

their poorly functioning organisms, and present a cheerful, optimistic front to daily life, there are thousands and hundreds of thousands who surrender unequivocally to the ills of their body, and become spiritually morose and hypochondriacal. Happiness is quite as definitely dependent upon a smoothly running body mechanism as upon contentment with one's lot; in fact, there is abundant reason for believing that the latter is realizable in its completeness only through the possession of the former. Certain it is that the happiest individuals you know — those who are most brimful of life and energy and enthusiasms — are those who are the healthiest. They do not have to feign happiness by manufacturing a sort of pseudo-contentment; they are really and essentially happy, and it is such folk who supply the motive power that propels mankind onward toward its greatest achievements.

Older concepts of hygiene. Modern hygiene has a strange heritage. The whole subject of health and sanitation occupied small prominence previous to the latter part of the nineteenth century. Indeed, throughout the Middle Ages the human body was looked upon generally and universally not as a temple of the soul, but rather as a prison in which the soul was constrained by circumstance to chafe and fret against the day of its unloosing. The confining tissues were but cumbersome fetters which interfered seriously with the upward soaring of spirits languishing for their native air. In keeping with this philosophy, it was considered that through denial and repression, and even mortification of the flesh, the soul within not only purged itself but in so doing expressed triumphantly its supremacy over the physical and the base. Asceticism being the order of the age, one is not surprised to read in the records left from those great mediæval wastes that "running, tilting, stone-throwing, wrestling, jumping, etc., are but devices of the Evil One for capturing

souls with pride." The body, being of the earth earthy, was regarded as an evil reagent of the soul, and all through the history of that period the dual struggle between the flesh and the spirit was waged unceasingly. The mediaeval scholastics and schoolmen exorted all men to neglect the base prison in which their souls struggled in vain to free themselves, in order to achieve a state more becoming them as prototypes of the All-Wise and the All-Good. As a result of this narrow philosophy, we find the most absurd practices and the most reprehensible neglect preached, heeded, and practiced by scholastics and laymen alike for hundreds of years. The earlier Egyptian and Greek physicians had been exceedingly superstitious and skeptical, though it is a fact that a great many diseases were known, classified, and described by these mystic medicine men of the classic period.

It was mainly, however, a legacy of superstition and ignorance that the ancients handed down to the early Christians, so that there is little wonder that the indifference to the body should not only be continued but should actually increase from generation to generation. General bodily cleanliness was minimized and even quite neglected; bathing was deemed harmful by many and looked upon with some suspicion by many more who practiced it. About the beginning of the Renaissance period the custom of wearing glasses by children came into vogue, it being believed that the sight was thereby improved! A hundred years later the use of tobacco began in the English public schools; public opinion deemed tobacco to be a great preserver and safeguard of health as well as a preventive against the dreaded black plague. In order that the body might be hardened, and thus permit the soul to develop and expand without handicap, many teachers would not permit fires in the schoolrooms even in the coldest weather; it was recommended that shoes be not impervious to water; that the time of eating be

not definite and fixed from day to day; thus, it was inferred, would the flesh become gradually subservient to the mind. Fruits, meats, and other varieties of food were often prohibited, as though openly to deny even the nutritional demands of the body.

Even as late as 1800 Goethe thus characterized the youth — especially the students — of his day:

> Near-sighted, pale, with hollow cheeks, young without youth — such are the majority as I see them. They show no signs of sound senses, or of pleasure in sensuous beauty; the sentiments and delights of youth are irretrievably lost, for if a person is not young at twenty, how can he be at forty?

Dickens, later still, in *Nicholas Nickleby*, thus paints a picture of childhood in England in the early nineteenth century which is far from being fictional:

> Pale and haggard faces, lank and bony figures, children with the countenances of old men, deformities with irons upon their limbs, boys of stunted growth, and others whose long, meager legs would hardly bear their stooping bodies, all crowded on the view together. There were the bleared-eye, the hare-lip, the crooked foot, and every ugliness of distortion that told of unnatural aversion conceived by parents for their offspring, or of young lives, which, from the earliest dawn of infancy, had been one horrible endurance of cruelty and neglect. There were little faces which should have been handsome, darkened with the scowl of sullen, dogged suffering; there was childhood with the light of its eye quenched, its beauty gone, and its helplessness alone remaining. . . . With every kindly sympathy and affection blasted in its birth, with every young and healthy feeling flogged and starved down, with every revengeful passion that can foster in swollen hearts eating its way to their core in silence, what an incipient hell was breeding there! . . . Little could be distinguished (as they slept) but the sharp outlines of pale faces, with here and there a gaunt arm thrust forth: its thinness hidden by no covering, but fully exposed to view in all its shrunken ugliness. There were some who, lying on their backs with upturned faces and clenched hands, just visible in the leaden light, bore more the aspect of dead bodies than of living creatures, and there were

others coiled up into strange and fantastic postures such as might have been taken for the uneasy efforts of pain to gain some temporary relief, rather than the freaks of slumber.

Newer conceptions of hygiene. Notwithstanding the general neglect that characterized the Middle Ages and, to a somewhat lesser extent, the centuries succeeding, it must not be supposed that the old adage of the philosophers, *mens sana in corpore sano*, had none to defend it during this period.[1] Thomas Haselbach, a theologian of the fifteenth century, recommended "all sorts of sports and contests, like throwing balls through a ring or at ninepins, running races, shooting with the bow, playing ball, etc." Luther declared that he personally was very fond of music and tilting, fencing, wrestling, and similar games, since they "drive sorrow and melancholy from the heart and develop the different parts of the body and keep it in health." He added, however, that "the real purpose is to keep people from going into drinking, lewdness, gambling, and dice-playing. This is what happens when these fine games and knightly sports are neglected."

Comenius (1592–1670) advocated physical training as an essential part of school instruction. Basedow (1723–1790) cautioned teachers "to accustom boys to frequent exercise of all parts of the body, and to put up with their hilarity and noise. . . . Teach them to swim, to walk over narrow footbridges, to lower themselves by a rope, to go up and down small elevations, to jump over narrow ditches and low fences, to use the vaulting-pole, to dodge thrown balls, to chase away a dog, to walk on smooth ice, etc." Herder (1744–1803) actually introduced formal gymnastics of a sort into his gymnasium at Weimar. Rousseau (1712–1778) and Pestalozzi (1746–1827) placed distinct emphasis upon

[1] For a brief discussion of some of the mediæval and post-mediæval champions of hygienic living, see *School Hygiene*, by L. Kotelmann, chap. 1.

physical culture and exercise as safeguards of health in the young.

Modern hygiene, built up as it has had to be, upon the superstition and inexactitude of the past, has only recently come to be separated from the limitations and fallacies that have clung to it throughout the centuries. In not a few communities of the present day the highest functions of a health department are popularly supposed to be the immediate protection of the people from infectious and contagious diseases, and the elimination of such nuisances as might become a menace to the public health.

It is true that, with the discovery of the germ-theory of disease and the development of the bacteriological sciences, in the last quarter of the nineteenth century, medical practice received a new impetus which has rendered it capable of coping with many of the most dreaded diseases of man. Hospitals, dispensaries, and sanitaria for the observation, care, and treatment of these maladies have multiplied rapidly. Medical schools have turned out splendid armies of scientifically trained physicians and surgeons, equipped with the skill which makes them masters of physical disease in many forms. The Age of Curative Medicine has been unquestionably a boon and blessing to mankind, and will continue so to be so long as there arise disease and suffering in the world.

The Age of Preventive Hygiene. But strikingly coincident with the coming of the twentieth century there began to appear here and there circumstances which indicated the passing of the Age of Curative Medicine, and pointed to the coming of a greater: the Age of Preventive Medicine — more appropriately termed preventive hygiene. Slowly but surely we are coming to realize that the most economical way to meet the problems presented by needless illness and premature death is to remove their causes by introducing

preventive measures. Public health departments have been tardy in reaching this point of view, but it has been circulated assiduously for several years by a large number of private and semi-public organizations, such as life-insurance companies, child-welfare associations, school-health writers and workers, health leagues, institutes, clubs, foundations, etc., etc. More and more this idea of preventing rather than waiting to cure disease and defectiveness is percolating down through the various strata of our society. Its influence is observable in the movement for health supervision of school children and pre-school children; in the phenomenal spread of baby-welfare stations and clinics in our cities; in the growth of the playground movement; in the establishment of open-air schools; in the promotion of school-feeding activities; in the popularizing of health exhibits and traveling clinics, sent out through whole counties and even States; in the anti-tuberculosis and anti-diphtheria campaigns; in the health lessons that teachers are now actually teaching their children; in the emphasis which recent books, periodicals, and other literature are placing upon the prevention of ill-health and in 'keeping fit,' and in numerous other practical movements in both juvenile and adult education.

This same modern spirit of prevention is being felt also in branches of hygiene other than educational. A similar transformation is taking place in industrial, community, and personal hygiene. Organizations such as the Rockefeller Institute, and the Carnegie and Russell Sage Foundations, are continuously engaged in investigative work in the field of public health, as are also the United States Public Health Service, the American Association for the Advancement of Science, the Chemical Foundation, the Life Extension Institute, and the National Association for the Study and Prevention of Tuberculosis, to mention merely some of the best known. These are being aided and supplemented by an

increasing number of local and national charitable, philanthropic, and social organizations, such as the Federation of Women's Clubs, medical and dental societies, public education associations, city and State health departments, chambers of commerce, labor bureaus, manufacturers and advertisers, normal school and college departments of hygiene, etc., together with a large number of other organizations and institutions directly or indirectly conducting continuous propaganda in the interests of preventive hygiene in the personal life, as well as in the community, and in the shops, factories, and other industrial and vocational establishments.

Hygiene and the child. An inspection of Table 4 tells an amazing story in itself. One infant out of every seven born in this country died during the first twelve-month of its

TABLE 4. SHOWING THE DEATH-RATE AMONG CHILDREN FOR THE REGISTRATION AREA, IN 1921

		PER CENT
Total number of deaths, all ages.	1,032,009	100.
Number of deaths under one year.	160,011	15.5
Number of deaths under five years.	220,688	21.4
Number of deaths under ten years	246,746	24.
Number of deaths under twenty-four years.	325,877	31.6

life;[1] one out of every five born died before reaching its fifth birthday; one of every four died under the age of ten years. After ten years of age there is a sharp falling off in the rate, but the number of children who die during youth and previous to the completion of the period of adolescence is nearly $33\frac{1}{3}$ per cent of the whole number, or approximately one in three. This wastage of human treasure, in the form of infant and child life, is tremendous — especially during the first ten years. A percentage of 21.4 is altogether too high

[1] This is on the assumption that the death-rate is not in excess of the birth-rate, as of course it is not in the United States

for national complacency and pride. Certainly the fact that a third of those born die by the mid-twenties, taken together with the fact that a third of the two thirds left are found so physically defective by examining physicians as to be unavailable for military service, should make us pause and cast about for some practicable means for improving a highly unsatisfactory condition.

The most obvious thing in the whole modern preventive movement is the conviction in the minds of every one engaged, either directly or remotely, in the conservation of human life and health, that childhood is the logical and practical starting-point for the building of health. A large percentage of the defects which led to the rejection, in 1917, of three quarters of a million men between twenty-one and thirty-one years of age could unquestionably have been prevented had the proper emphasis been placed upon the acquisition and retention of health during the early years, in and out of school. Chronic and long-standing defects of teeth, of eyes, of ears, of nutrition, of muscular and skeletal development — all of which stood high in the causes for rejection in making up the personnel of our expeditionary armies — ought to be indefensible in any youthful group, whether selected or unselected.

Yet what has our system of school medical inspection revealed? The facts here are equally disconcerting. From 20 to 25 per cent of all pupils are found to have defective vision, ranging from slight eye-strain to extreme myopia and astigmatism. Defective hearing, due often to the after-effects of various forms of throat infection, is found in 5 per cent of the school population. Approximately 10 per cent are suffering from malnutrition of a grave nature, while the nutrition of another 10 per cent is distinctly poor. Ten per cent have enlarged cervical glands, many of them tuberculous, while 10 per cent more have tuberculous infections of

such a nature that they will later succumb to the ravages of the great white plague. Fully 50 per cent have seriously defective teeth in need of prompt attention. Ten per cent have adenoids or infected tonsils. Five per cent have spinal curvatures or some other skeletal deformity likely to interfere with health. Five per cent more are afflicted with some form of serious nervous disorder. If we include in this gruesome category those children who are in a weakened condition as a result of the children's diseases, of unhygienic home conditions, of an excessive amount of outside labor, of an insufficient amount of sleep, of the toxic effects of coffee and tobacco, etc., etc., we shall come to appreciate more keenly the importance of a wise regimen for childhood if future defectiveness is to be guarded against.

From every part of the United States come reports of medical inspectors confirming the conservatism of these percentages. Thus, examination of 483,000 Pennsylvania children[1] (1919–20) showed that 75 per cent of them were physically defective; 60 per cent had defective teeth; 16 per cent, defective vision; 27 per cent, enlarged or diseased tonsils. Of 59,000 children recently examined in Detroit, 19 per cent were ten pounds or more underweight. In Omaha, in 1920, 22,249 school children were examined and a gross total of 18,882 physical defects was found. Of 100,000 repeaters in the New York City schools, 50,000 have defective eyesight alone. At Stratford, Connecticut, 550 children were examined and only one child found to have teeth free from decay. In Youngstown, Ohio, 20 per cent of 11,730 children were suffering from infected tonsils. At Lincoln, Nebraska, 52.6 per cent of the children examined had hypertrophied tonsils, while 31.4 per cent had nasal obstructions.

And so the story runs.

[1] Cf. *Proceedings of the Thirteenth Congress of the American School Hygiene Association,* New York City, 1921.

Health and the school. To the assertion made in a preceding paragraph that childhood is the logical starting-point for the building of health, it is but a corollary that the school, as the accredited organization already in existence for the training of childhood, offers the natural point of departure for health-building. Essentially and practically, health education is as legitimately a function of the school as is training in the three R's. The physical is as substantially a part of life as are the spiritual and the intellectual, and as such merits its own appropriate culture. The day, if it is not already here, is fast approaching when the former will be emphasized in our educational system quite as prominently as the latter. Somewhere between the extremes of, on the one hand, the Spartans who magnified and glorified the physical, and, on the other, the Mediævalists who extolled the spiritual-intellectual, the Utopian system of education, when it is once ushered in, will hit upon the happy mean wherein both these opposite endowments of humanity will be placed in their proper relationships — mutually intertwining and hence educationally inseparable.

In the meantime, there are those who raise the absurd cry of "Paternalism!" whenever and wherever a program of school health inspection and education is proposed. Whatever the motives of such propagandists, the merits of their assertions are proven valueless when, as is invariably the case, the reputable medical men and organizations of the community ally themselves with the school health workers and render generous and usually grossly underpaid service in behalf of unwell and defective children. The propagandists cry: "The parents are the arbiters of a child's destiny! The State is usurping their prerogatives!" The conventional medical man says nothing, but gives nobly of his time and skill in redeeming the unwell children and in doing preventive work among the well. The one would deny the State's

interest in the child; the other would hew out of the child a better citizen for the State. Until the time is happily come when every parent is intelligent enough or thoughtful enough to oversee carefully the health and physical development of his children, there can be no alternative but that the State must step into the breach and guarantee, along with their mental and moral training, the future physical soundness and robustness of her citizens.

Scope of the present volume. In the ensuing lessons we shall endeavor to present as fully as practicable such facts, ideals, and practices as may fit the future teachers of boys and girls, first, to be intelligently interested in their own health and vitality; second, to be sympathetically familiar with the school health program and purpose; and third, to be able to perform, with some measure of skill and conviction, their own peculiar part in that program and purpose.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Secure, from your local board of health, the mortality statistics for your community over a period of several months. Tabulate the number of deaths under one year; under five years; under ten years; under twenty-four years, with the percentage of incidence of each. Calculate the gross economic loss to the community from these deaths.
2. Find, in the *Provost Marshal General's Reports* for 1917 and 1918 to the Secretary of War (which may be procured free from the Adjutant-General's Office, Washington, D.C.), the statistics for rejection on physical grounds of recruits in your community or State. How does your locality compare with others? With the best and poorest?
3. Evaluate your own personal health on the score of: (1) energy and strength sufficient for daily work; (2) inclination and energy to play; (3) probabilities for large human service; (4) attractiveness, charm, and vitality; (5) efficiency in your profession; and (6) happiness. In all probability what will be the case five years hence?
4. Write a brief paper on the topic: "Preventive Hygiene or Corrective Medicine?"
5. Make a list of as many organized health agencies, both public, private, and quasi-public, as you can find any reference to.
6. Look up, in the latest report of the health officers in your town,

county, or State, the present status of school health work in your part of the country.

7. Enumerate as many arguments as you can in support of and in criticism of those who claim to see in systematic and organized health education an infringement of the responsibilities of the home. Or, submit arguments for a debate on the topic: "Resolved, that organized school health work is a form of paternalism and should be discouraged."

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CHAPTER II

THE TEACHING OF HYGIENE

Introduction. Before turning to the study of educational hygiene proper, it will be wise, for at least two reasons, to devote this and the next lesson to the pedagogy of hygiene. In the first place, the primary reason for the inclusion of educational hygiene in the professional curriculum of teacher-training may be said to be in order that the future teacher may be properly oriented in the general subject of hygiene. It is important at the very outset that she understand fully her responsibility as well as her opportunity in the field of public health. Hers is not the prognosis and the prescription of the medical man; nor the inspection and visitation of the nurse; nor yet the routine of the health official or administrator: she is simply the health *teacher*, as she is also the teacher of a dozen other arts.

The teacher therefore studies hygiene as she studies everything else, not primarily for her own self-improvement, nor indeed to make herself an expert in the realm of health and disease, but rather to develop in herself a strong health consciousness and point of view, and to amass a fund of practical information and experience which can be profitably worked over and passed on to boys and girls. The child, as she deals with him every day in the classroom, is her point of attack. Everything she learns must be related in some way to him. He is the daily and continual patron of her professional service.

In the subsequent lessons of this book, therefore, it is of high importance that the young teacher shall bear always in mind the fact that the child is focal, and that, in conse-

quence, while incidentally increasing and supplementing her own knowledge, she shall learn to think of hygiene in terms of teaching it to children.

The second reason for including these lessons on the pedagogy of hygiene at this point grows naturally out of the first. If the teacher in training is to cultivate the child-health point of view, she must have practice in the art of planning and developing health lessons that can be taught interestingly and appealingly to children. In this and the following lesson an effort will be made to indicate how hygiene lessons can be thus successfully planned and presented.

Why has hygiene-teaching been traditionally poor? It is not unlikely that if you were to attempt to recall the lessons in hygiene which you had in the elementary school, you would find that they were very few indeed. Many schools give no systematic training in health habits whatever beyond insistence upon passably good standing and sitting posture, and possibly the brushing of the teeth. Many more subject their small patrons to a torturing series of mongrel lessons in physiology, anatomy, and hygiene, with the minimum of emphasis upon the last named and the maximum upon the first two.

Teachers have almost universally pronounced this so-called but miscalled "hygiene" a failure as it has ordinarily been taught. And failure indeed it has too often been, partly because they could not get away from the anatomical viewpoint which the textbooks were guilty of exploiting; partly because they themselves have had little or no training in the subject; and partly because they have not understood the psychological method of approach to the subject. Instruction in physiology has been therefore little more than a sort of formal drill in the principles of human anatomy, which are at best of small interest and smaller value to school children. In one schoolroom recently visited — in

which the thermometer read 76° F. — a teacher was found to be expounding from a textbook the intricacies of the lymphatic circulation to a class of boys and girls twelve *years of age!*

No textbook in physiology ought ever to be found in an elementary school, nor should the words 'physiology' and 'anatomy' ever be mentioned in more than an incidental manner by the teacher. We must shift our emphasis from 'structure' and 'function' to 'hygiene' and 'health.' It matters little whether a thirteen-year-old boy knows the scapula from the clavicle, provided he has been trained to stand and sit erect; nor is it vital whether a ten-year-old can describe the structure of his teeth, provided only he has formed the habit of keeping them clean. Any instruction beyond the hygiene of an organ — plus enough physiology and anatomy to render this knowledge fairly intelligible — has no place in the elementary school. Unfortunately, however, this has not been the case in most of our schools up to the present time.

A case in point. In order to indicate definitely the unfortunate prominence which physiology and anatomy still have in the hygiene courses in the public schools, there is quoted below a section from a syllabus on health, recently published by the Board of Education of a large city and placed in the hands of the teachers under its control, to the end that they might have the necessary material "to teach and train pupils in correct health habits." The section quoted is entitled "The Heart," and is intended for sixth-grade pupils. As you read the passage, try to form a judgment as to exactly what "training in correct health habits" would be supplied from its study to boys and girls eleven or twelve years of age.

The heart is likened to a pump, which constantly forces the blood through the blood vessels.

The human heart is about the size of a fist.

It is situated in the upper left portion of the chest.

It consists of four chambers:

a. The right auricle.

b. The right ventricle.

c. The left auricle.

d. The left ventricle.

The outlet of each one of these chambers has a protecting valve, preventing the blood from flowing back.

a. The right auricle has a 'tricuspid' valve.

b. The right and left ventricles each have a 'semilunar' valve.

c. The left auricle has the 'mitral' valve.

The heart is a muscle with the power to contract and to return to its normal size.

The chambers in turn contract and force the blood out of one cavity into another chamber or blood vessel, as the case may be.

In this order: The venous blood enters the right auricle, when filled it contracts and forces the blood into the right ventricle. Upon contraction the blood is forced through the pulmonary artery into the lungs to give off impure air (gases and water) and to take up fresh air (oxygen). It then returns through the pulmonary vein into the left auricle, which contracts when filled, the blood entering into the left ventricle. From here it is forced by contraction of the left ventricle into the aorta, starting on its journey through the body, to return and to continue in the same way again.

The contractions of the heart and the closure of the valves cause the heartbeat.

The heartbeat can be heard by placing the ear against the left side of the chest.

Average heartbeat in baby 120–140 beats per minute, in adults 72 times per minute.

Exercise, excitement, fear, anger, and illness (fever) make the heart beat faster.

One might almost fancy the foregoing syllabus to have been designed for elementary students in college and normal-school courses in anatomy and physiology!

The result in the minds of the pupils. It is the policy in one of our large Western States to require all pupils completing the eighth grade to pass a State examination in the

several subjects which they have studied. Not long since, Professor F. M. Gregg collected and published[1] some typical replies made by children in one of the best educational counties of the State to the questions in the hygiene examination. Here are a few of them:

A common disinfectant is smallpox.
Mastication is what is going on.
Epidermis is a certain kind of medicine.
The diaphragm is another name for backbone.
The bones are made up of hard mucous membrane.
Pericardium is something that will put you to sleep.
Respiration means all the different juices in the body.
The diaphragm is very delicate and located in the head.
Fumigation is when the air is shut off and death may come.
The Eustachian tube is a tube running all over the body.
The nervous system is a kind of tube where the blood vessels are in.
The process of digestion causes headache and much impure blood.
Fried potatoes often cause digestion.
A disinfectant is anything you catch by going where they are. Measles and chickenpox are disinfectants. When you have them you should stay in the house and keep warm and try not to give them to others. Pimples on the face are not disinfectants, but some kinds are.

It is not difficult to conclude what the course of study pursued by these children was, and where the chief emphasis was placed. It must obviously have been constructed after the pattern of the syllabus referred to above, with anatomy and physiology as the basic subjects rather than hygiene and health. No wonder, considering the general meaninglessness of the terms which the children were presumably supposed to understand — and, no doubt, memorize — that in recall 'epidermis' became a kind of medicine, the 'diaphragm' was confused with the vertebra, 'pericardium'

[1] In *The American Journal of School Hygiene*, vol. 1, no. 5, 1917.

with 'chloroform,' 'fumigation' with 'suffocation,' etc., etc. These names meant nothing, of course; hence they became easily confused and interchanged in the minds of the pupils. It would be hard to conceive a grosser waste of time and effort on the part of teacher, pupils, and examining body than this! And all this notwithstanding the fact that, if there is one subject in the whole curriculum which ought to be made to exert a large influence over the future lives of individuals, that subject is unquestionably hygiene. Unfortunately, the truth of the matter is, on the other hand, that if there is one subject of study in the curriculum that has failed notably heretofore in its manifest purpose, that subject has been this same hygiene.

The new ideal in teaching hygiene. And yet the subject of hygiene can be made just as fascinating and just as permanently of value as any other of the common branches ordinarily pursued by boys and girls of school age. In fact, because of the immediate and profound relationship between personal and community hygiene, on the one hand, and the life and happiness of human beings, on the other, it is doubtful if any subject in the entire curriculum is fraught with such possibilities of compelling interest and purpose for boys and girls, provided only that the proper methods of handling the matter be followed by the teacher.

The end of hygiene-teaching is not anatomical knowledge, but trustworthy health habits and health attitudes. The far too common practice of presuming to teach young children under ten or twelve years of age the physiological effects upon the system of stimulants and narcotics, or facts concerning the structural anatomy of the body tissues, or the functions of organs, or the circulation of the blood, or the secretions of the glands, etc., is absurd. Yet these are but a few of the topics mentioned in many courses of study for children in the lower grades, and in part often required by

the laws of the States. The mind of the child at this tender age cannot grasp material of this sort. Information must be concrete, definite, and simple of comprehension.

The "good citizenship" test. The aims of education have been variously defined by different writers and theorists of the past and present. The best working definition of education appears, however, to be training for social adjustment, and from this viewpoint the highest test of the public school is to be found in the kind of citizens it turns out. Man's real worth is social, not individual; community, not family. Democracy means more than a job and a home; it means also citizenship and communal living. It implies coöperation and interdependence; it means freedom under the law; it means altruism and forbearance. Good citizenship in a democracy is, in other words, positive and dynamic.

The "good citizenship" point of view is coming to be the slogan of many of our best schools. The earlier and narrower notion of civics as being concerned chiefly with problems of local and State government has yielded to the newer conception of civics as embracing the whole range of man's social relationships with his fellow man. Obedience to law is liberty — and liberty merely; appreciation of law is citizenship. The former means simply freedom from restraint — passivity; the latter means coöperative citizenship — activity.

The acid test of every hygiene lesson taught to boys and girls in the schools might quite properly be this: Does it point the way to good citizenship? Is a child, in other words, a better citizen or on the way to become a better citizen, because he is taught, on the one hand, how alcohol affects the tissues of the digestive and the circulatory systems, or how, on the other, it affects thrift and self-respect? Is he a better citizen because he understands the lymphatic circulation, or because he loves exercise and play? Is he a

better citizen because he knows that there are twenty-six vertebræ in the spinal column, and that the twenty-fifth is the largest one, or because he is earnestly at work on the improvement of his own postural habits? Is he a better citizen because he knows that arterial blood in the systemic circulation is oxygenated, or because he knows how to apply a tourniquet above a severed artery? Is he a better citizen because he knows the meaning of "sclerotic" and "choroid," or because he knows how to take care of his eyes? Is he a better citizen because he is taught the difference between the oil glands and the sweat glands in the dermis, or because he is taught how to keep his skin both clean and vigorous? Is he a better citizen because he is taught the chemical changes which food undergoes in the stomach and intestine, or because he is taught how to select proper foods for his diet?

The answers to these questions are too obvious for comment: the good junior citizen is the one who is forming fundamental health habits and attitudes rather than the one who is burdening his mind perforce with physiological and anatomical facts, which not only possess little if any intelligible meaning for him, but which, owing to the painful process of learning, render him in subsequent years more or less disinterested in the general field of public health. The latter outcome is as undesirable as the former.

It cannot be doubted for a moment that the child who grows up with a health consciousness which has been wisely and broadly cultivated throughout his school life will be for that very reason a citizen with a higher and broader civic consciousness. Just as arithmetic, grammar, and history function in maturity, so hygiene will likewise, if properly taught, modify future action and attitudes. Neighborhood or community sanitation and hygiene offer one of the finest sources for field work in community citizenship for older

children. Community health is a phase of hygiene which has received scant attention in the past, and almost none thus far in the schools. It is apparent, however, that no one can be a thoroughly good citizen and be at the same time ignorant of some of the great principles underlying the wider aspects of hygiene and sanitation. Here is a field where it is easy to demonstrate to school children in how far we are all our brothers' keepers. The great lesson of coöperation may be learned here in such a direct way that it can never be forgotten.

Aids and devices for effective hygiene-teaching. A fundamental principle underlying effective teaching of hygiene is to be found in the psychological method of approach. No capable teacher of the modern school would think of teaching lessons in division, or grammar, or spelling without basing her procedure upon the established principles of child psychology. Wherefore, then, expect to teach matters of health to boys and girls by having them read from a book and recite more or less *verbatim* the impressions therein received? The teacher will do well to apply her psychology to the planning and teaching of the hygiene lesson as well as of the other lessons of the day. The motives which she may make use of in training children to respect and exemplify in their own conduct the laws of personal and community health are, after all, to be found within the children themselves. Among such motives, which obviously vary somewhat from grade to grade, may be included pride; emulation; imitation; class, group, and individual rivalry; activity; approbation; ambition; sportsmanship; curiosity; the soldier interest; inventiveness; the athletic interest; the social instincts; the dramatic interest, etc. We shall have more to say about these and other motives in later paragraphs.

The Health Club. By all means, in grades above the fourth, the old-fashioned "recitation" idea should be done

away with so far at least as hygiene is concerned. Let the room be democratized as far as it is feasible during this period, if at no other time. Lead each child to feel that he is a part of a small community that is met together to discuss matters pertaining to the welfare not only of the miniature school society, but also of the wider community beyond the school premises. One of the greatest evils in our present system of education lies in the strange paradox that school precepts too often do not leave the school premises when the children do. Instruction is a sort of fickle dog that comes leaping to meet the owner when he enters the school yard, plays and capers around him interestingly during the day, but which, when the session closes, slinks into the shadows of the yard the while the master passes out the gate into the outer world, nothing loath to be rid of his pestiferous companion. There is not, in other words, that constant and mutual relationship between the two existences of the child which ought ideally and logically to be the case.

Every one knows that there is a schoolroom language and an outside language, for example; a schoolroom attitude and an outside attitude; a schoolroom civics and an outside civics; even a schoolroom spirit, voice, mood, initiative (or rather lack of it), courtesy, industry, posture, etc., and an outside spirit, voice, mood, initiative, courtesy, industry, posture, etc. And most of all there is — or certainly has been in the near past — a schoolroom hygiene and an outside hygiene; a schoolroom conception of health and an outside practice of and interest in it. Children have been encouraged to talk glibly of physiologic processes and hygienic or sanitary principles; but all too rarely indeed, in the experience of the writer, has such glibness become an incentive for modifying or enriching or supplementing the way of living of most individuals who have sat their allotted span of years under the perennial exhortations of lecturer-teachers,

or drunk enfeebling and de-energizing draughts from poured-in textbooks.

Let the teacher beware, then, of the old-fashioned methods of teaching hygiene. They may do very well for teaching Greek, or archæology, or perhaps even agriculture in a girl's seminary; but for virile training of boys and girls in practical and usable health habits and attitudes — never. Such training must be eminently a participative process, a one-hundred-percent-enrollment process.

And how shall we organize the hygiene class in order to encourage and promote this participative process? In a certain school known to the author the children have been organized into what is called a "Keep-Fit Club." Such other suggested names as "Good Health Club," "Health League," "Sound Body Club," etc., were forthwith dismissed from consideration by the children as not being so challenging, so *pioneering*, as "Keep-Fit Club." Possibly the soldier motif was at the basis of this feeling on the children's part. The club elects one of its members president, another vice-president, and a third secretary. In addition to these officials there is also a committee on meetings, to which the teacher, *ex-officio*, belongs, and which with her determines upon interesting problems to be investigated by the club. No one — not even the teacher — would think of referring to the weekly club meeting as a 'class,' much less a 'recitation.' It is rather a Club Meeting. The president presides, save when the vice-president is able by sheer power of logic to wrest temporarily the chairmanship of the meeting from the hands of the chief executive. Nominally, he is to direct the club in its discussion of the problem which chances to be up for consideration. Actually, however, the children need little guidance — even from the teacher. Occasionally, it is true, they stray away somewhat from the set topic, but they usually find themselves

shortly, and as time goes on they tend to diverge less and less from the aim which they have set up for themselves for the meeting.

Interest in the meetings of course runs high. Personal experience is more and more often summoned up as the year progresses, and gradually some of the children even become so bold as to venture to propose and defend opinions of their own, which may be quite at variance with those of others — surely an innovation in not a few schoolrooms. The offices of president and vice-president rotate around the class in the course of the year, so that the best principles of democracy are always in evidence in the political complexion of the club. The teacher moves dimly across the background of the club setting, but her part and presence are decidedly inconspicuous. Textbooks and hygiene readers are always available, and often furnish the entire groundwork for a meeting. Pictures and posters and varieties of other illustrative materials are always to be had in abundance. Initiative, self-control, self-reliance, independence and suspension of judgment, argumentative resourcefulness, and other attitudes and attributes of mind are developed, as well as courtesy, broad-mindedness, and — above all — an intelligent and apparently permanent interest in the general subject of hygiene and health.

Dramatic presentation. The dramatic instinct is fundamental in children of all ages, and there is scarcely a topic in hygiene that does not lend itself readily to presentation in dramatic form. In a first grade recently the following very simple incident was thus portrayed. It was suggested by the children, after the teacher had told them that they should eat but little candy, and then properly only after meals. Gertrude was chosen to be the star performer. She leaned her elbows upon the table, her head in her hands, complaining that she was sick. Mother anxiously smoothed

Gertrude's hair, and then determined to telephone the doctor. He arrived in great haste, with his bag and glasses! After he had examined Gertrude's tongue and noted her pulse he asked her suspiciously — and not without some display of medical cleverness — if she had been eating candy. "Oh, yes! I ate a lot just before breakfast!" was the reply. The doctor shook his head reprovingly, and reached for his hat. "You see what happens when you do that!" he exclaimed, crooking his finger at the patient. "You must learn to eat your candy after breakfast instead of before — and then only a little, too! Candy isn't very good for you anyway!"

A very simple bit of dramatization, indeed, but for that very reason it was fully comprehensible to the children, and both actors and audience thoroughly enjoyed it. The setting was a familiar one to all, and the acting was as extemporaneous as it was pointed. In this homely way even very young children may learn that there is a cause and effect in matters of health, and that there is a reason why certain rules of living are prescribed by mother or teacher.

In all grades dramatization of health themes is a very interesting and novel way to impress upon the minds of children the importance of wise health habits of every sort. On the following pages, for example, is reproduced a health playlet entitled "The Wizardry of Milk," which is one of several pieces of health dramatization presented at the Grand Central Palace in New York during the Milk and Child Health Campaign, in May, 1920. It is here reprinted by permission of the American Child Health Association.[1]

[1] These playlets are all obtainable in a pamphlet entitled: *Health Plays for School Children*, from the American Child Health Association, 370 Seventh Avenue, New York City.

FIG. 1. THE WIZARD AND THE ACROBATS IN "THE WIZARDRY OF MILK"

THE WIZARDRY OF MILK

Characters: The Wizard — Two Acrobats — Three Singing Girls — A Dancing Girl — A Soldier — A Sailor — A Doctor — A Nurse — A Fireman — A Farmer — A Farmerette — A Mother with a Baby Carriage — An Old Couple.

The costumes in this play are easily procured and few would have to be specially made. The Old Man has a gray cotton beard and hair. The Soldier wears a Boy Scout uniform, and the Acrobats have jerseys, long stockings, and trunks made from bloomers. The Wizard's long cream-white gown, cape and pointed hat are decorated with black paper cows and half-moons.

Properties: A huge cardboard milk bottle in center of the stage.

WIZARD (*enters and says*): "I am the Wizard of Milk and I am going to show you something wonderful. When I clap my hands, watch the milk bottle!"

(WIZARD *claps hands and from each side of bottle an Acrobat comes bounding out. They bow. They proceed (1) to turn somersaults; (2) then the wheelbarrow (one acrobat walks on hands, while the other holds his feet); (3) one acrobat takes up a large ball marked "100 lbs." and lifts it slowly with both hands, showing the "strain" on his face; finally, holding it triumphantly in one hand, he tosses it to the other. They toss and catch it several times; (4) they wrestle, in the midst of which the* WIZARD *calls out:*

"Stop, aren't you tired?"

"No, we are not tired!"

"Why aren't you tired?"

"Because" (*triumphantly*) "we drink at least a pint of milk a day!"

(*They bow and step, one to the right and one to the left of the stage.* WIZARD *claps again and three girls come skipping out from behind milk bottle. They bow, then sing two songs. When they have finished,* WIZARD *says*:)

"How well you sing! But aren't you tired?"

"No, we are not tired. We could sing all day long."

"Why aren't you tired?"

"Because we drink at least a pint of milk a day!"

(*The two girls then stand behind acrobat at left, other girl beside one at right of stage.* WIZARD *claps hands again, and from behind milk bottle comes a little girl who bows, then does a little dance. When she finishes* WIZARD *says:*)

"How beautifully you dance! But aren't you tired?"

"Oh, no, I am not tired. I drink at least two glasses of milk a day."

(DANCER *then stands next to two children at the right.* WIZARD, *turning to audience:*)

"Now I am going to show you what you can do when you are big, if you drink at least a pint of milk a day when you are little."

The following characters — all small children and of about one size — step out from behind the milk bottle, each in response to a clap from the WIZARD:

SOLDIER (*saluting*), SAILOR (*saluting*), DOCTOR (*carrying bag*), FIREMAN, NURSE, FARMER, FARMERETTE, MOTHER *with Baby and Carriage, and finally* OLD COUPLE *who slowly take their places in space left between* NURSE *and* FIREMAN.

One by one they step forward (*with exception of* SOLDIER *and* SAILOR *and* FARMER *and* FARMERETTE *who speak in couples*) *and speak the following lines:*

SOLDIER, SAILOR (*saluting*): "We must be strong to serve our Country."

DOCTOR: "I must be strong to keep people well."

NURSE: "I must be strong to help the doctor keep people well."

FIREMAN: "I must be strong to save lives and property."

FARMER *and* FARMERETTE: "We must be strong to raise crops to feed people."

MOTHER (*with Baby*): "I must be strong so that Baby can be strong."

OLD COUPLE: "We have been strong and healthy all our lives."

ALL: "Tell us how!"

OLD COUPLE: "By drinking at least a pint of milk a day."

(*All go out except* WIZARD:)

"I have something more to show you. When I clap my hands watch what will come."

(*He claps and a number of children carrying health posters in front of them line up across the stage.*)

WIZARD: "Where did you get all these fine pictures?"

One Child answers: "We had a health drive in our school, and our drawing teacher, Miss Schaefer, showed us how to make them."

WIZARD (*to audience*): "I'll read them to you."

(*He reads such health slogans as follows:*)

"To be a healthy and strong child sleep nine or ten hours each night. Do you?"

"Milk makes her happy and healthy."

"Every child needs at least two glasses of milk a day."

"Mother gives me fruit instead of candy."

"Eat three regular meals a day."

"Eat at the same hour each day."

"Oatmeal made *me* strong."

"Milk and eggs are good for children."

"Clean your teeth night and morning."

"Eat fresh fruit every day."

"I'm hungry — bread and butter and milk for me."

"Sleep with your windows open."

(*After he has read them all,* WIZARD *turns to audience and shaking his finger solemnly, says:*)

"Follow these rules and you will be healthy all your days."

Any teacher will find her children eager to work out the setting and plot of a health play such as this, and to participate in its presentation. Exercises of this sort are excellent for instructive entertainment at the general school assembly

periods, at morning exercises, and on demonstration days, as well as for the occasional enjoyment of the children within the particular grade developing them.

The health project. *For the intermediate and upper* grades there is no more interesting and valuable method of investigating the subject of health than by the carrying-out of well-organized health projects. While the field of community hygiene and sanitation undoubtedly is richest in possibilities of this sort, the range of health projects is limited actually only by the cleverness of the teacher in conceiving and suggesting them, and opportunity and time on the part of the children to carry them out. For the rural school, too, obviously the same possibility exists of building a series of hygiene projects that will exemplify to the children the fundamentals of rural health, and interpret to them the essential facts of healthful citizenship. In the following paragraphs are presented suggestions for several projects in community health. Can you think of others?

1. *Learning about the local board of health.* The carrying-out of this project may be delegated to several teams. One will find out the names of the persons on the board; how, when, and for how long they are appointed or elected; what their salaries are; and whether or not they are physicians or laymen. Another will concern itself with the financial phase, finding out from available reports how much it costs the community annually to maintain its board of health; what portion of the income from taxation is thus used up, etc. There will be abundant opportunity here for correlation with arithmetic. Still another team will investigate the various duties and activities which the community has a right to expect of its health officials, and in how far the present board is meeting these expectations. It will be a revelation to most of the children to discover that the work of the health department is classifiable into a considerable

number of divisions or bureaus, each one of which nominally at least exercises some measure of control over the general health, comfort, and happiness of the community. In addition to all of these lines of attack, a group might very profitably make a survey of the leading health and welfare agencies of the community, apart from the established board of health, and make a report in club meeting upon the activities of these private or philanthropic or quasi-public organizations. In this way the children will come to appreciate something of the value of and field for individual participation in looking after the health of the community. Public boards of health, they should come to realize, are indispensable, but after they have fulfilled all of their proper functions there yet remain ample opportunities and appalling necessity for charitable enterprise on the part of public-spirited citizens and societies.

2. *Finding out about local disease incidence.* Most local boards of health issue monthly statistics covering the incidence and extent of communicable and other diseases during the preceding thirty days. Only relatively few citizens are aware of the type and prevalence of disease, or of the fact that exact information on the subject is available periodically from the health department. It has been the experience of most teachers of civics and hygiene that older children take an absorbing and healthfully impersonal interest in the disease incidence and death-rate of their community, county, and State. For a child to be taught that the mortality rate for tuberculosis, or for pneumonia, or for typhoid fever for the registration area of the United States is such and such a per cent, is likely to have no lasting impression or significance. But for the same child to keep watch of the rates for his own city, whether for the purpose of comparing them with those of some other locality or for mere informational purposes, the result is quite different. The hygiene

club may well consider this absorbing topic, perhaps keeping pin-charts on the walls during the winter months, showing at a glance not only the predominating diseases of the season, but their distribution over the city as well. One group of children may work upon the problem of how to read local mortality statistics, and whether the same method of tabulation and reduction is exemplified in the State and National statistics. Another group may plot and explain prominent diseases in the community. Still another group may interview the health authorities and inform the club how the department manages the mechanical side of keeping its fingers tolerably accurately and constantly upon the health pulse of the community. Finally, an enterprising team may secure all possible information as to the organization and functions of the State board of health in so far at least as they relate to the tabulation and publication of statistics of disease. In this way the children may get some practical notion of the niceness of articulation of local with State and even with National departments.

After the first reaction of amazement on the part of the health officers of the city to find its growing citizens already manifesting an interested concern in their work has passed, they will not only be willing but glad to render to their youthful interlocutors an account of their stewardship of the city's choicest treasure-in-store: its health. It may also result in setting them to thinking, as they may never have thought before, upon their opportunities and responsibilities. No doubt they will be glad to furnish a speaker from their department, on request, who can bring to the boys and girls of the club a most interesting and challenging message.

3. *Investigating the city water supply.* Excellent opportunity for a field trip will be offered in the prosecution of this project. This may either be made on a holiday, on Saturday, or perhaps after school. At all events, unless the

reservoirs are too inaccessible, every effort should be made to have the club actually visit and study them. Ordinarily the city water department will be able to supply the services of some one of its force as guide and 'lecturer' for the short time which the club and the teacher can devote to the actual inspection of the preserve. In the event that the system is situated too far away, or a field trip to its vicinity is otherwise infeasible, at least the lecturer should be invited to tell the club something about what a city water department means in size, extent, cost of upkeep, planning for future expansion, purification, filtration, etc., etc.

But before the club is ready for this information, it will need to investigate a little for itself. One team will find it an interesting project to learn the exact source or sources whence the city reservoirs derive their supply. Home geography may be correlated here very nicely. Another team will study the purification and filtration processes; another the pressure and pumping systems; another the nature and location of the mains beneath the city streets; another the house pipes, meters, shut-offs, etc. Pictures of the old Roman aqueducts — obtainable in the Perry pictures and elsewhere — will serve to add interest to the endlessly fascinating story of man's perennial and often herculean efforts to force pure water across great distances from an abundant source of supply to his own common habitation.

4. *Learning about the milk supply.* This is always an interesting topic to investigate. One team will set itself perhaps the task of determining roughly how much milk is required daily to meet the demands of local consumption. A second team will study the chief sources of supply of this food, together with the main routes of its importation into the city. A fourth will make a survey of the number of local distributors; the length of their routes; glaring cases of distributive duplication — such for example as when four dif-

ferent milk teams were noted by one child to be delivering milk daily in a single short street on which there were six houses. A fifth will inquire into the precautions required to be taken by dealers and distributors and producers in order that the purity and cleanliness of the milk supply may be safeguarded. A sixth will report upon the values and cheapness of milk as a food. Still other teams may study such related topics as Pasteurization, distribution centers, care of containers, cost of producing milk, cost of transportation, associations of milk dealers, etc. Ample opportunity all along the line is offered for correlation with arithmetic and local geography.

5. *Finding out how diseases are spread.* This constitutes a much more valuable field of inquiry on the part of boys and girls than does a mastery of the intricacies of the body circulations, glandular secretions, nervous pathways, etc., etc. One team may experiment in an elementary manner with yeast as a typical bacterium; another may investigate the fascinating story of the conquest of yellow fever, thus studying a common protozoan disease; another may tabulate graphically the number of people who die locally from preventable communicable disease; another may report upon certain sanitary principles and precautions to be observed in the care of the sick; another may learn about toxins and anti-toxins, etc. Any number of specific contagious diseases, such as the ordinary so-called children's diseases, may be studied by different groups. One group may work out a set of health rules to be presented to the club for discussion and possible adoption as club mottoes, slogans, etc. Other related topics under this caption should include: care of wounds; open windows; ventilation of schools, theaters, public buildings, etc.; individual and common drinking-cups; expectorating in public places or in public conveyances; vaccination; outdoor sports and exercise, etc., etc. The spread-

ing of disease is a topic sufficiently broad to include practically everything in any sense related to the activities and deliberations of the "Keep-Fit Club."

6. *Finding out about the fly nuisance.* The most appropriate time of year for entering upon this project will be obviously in the spring — just at the beginning of the fly season. One team will find out how flies are able to carry about with them the germs of disease. (There are now available excellent slides for covering this whole topic.) A team will report upon the life history of the fly. The entire club membership will divide itself into teams for the purpose of investigating all possible breeding places for flies in their several neighborhoods. Subsequently some or all of them will learn about the methods of treatment of breeding sources in order to render them safe, and will actually so treat as many as possible of them, reporting upon their results in club meeting. Fly-traps may be constructed in manual-training class, and attached by children to their own garbage pails at home. Local newspapers should be requested to give some interesting publicity to the work which the club is doing in the extermination of the common house fly. It will prove an interesting related project in arithmetic to calculate the expense which the people of the community are obliged to bear annually in the screening of their doors and windows against the fly intruder, to say nothing of the remarkable variety and array of fly-papers and poisons that clutter their homes and stores! The State board of health will be glad to supply without charge abundant literature dealing with the whole matter of the fly nuisance. "Fly weeks" may be entered into, in conjunction with "Keep-Fit" clubs of other schools, and the attention and interest of the entire community be thus enlisted toward the possible abatement of the fly nuisance from the neighborhood.

A similar project aimed against the mosquito may be

worked out by the club, and prosecuted with similar good results.

7. *Poster work.* The making of health posters by the children not only provides them an interesting means of expression of health ideals, but affords opportunity for correlation with drawing, handwork, and language. Inter-grade and even inter-school poster contests are occasionally arranged and carried out by teachers, and a final exhibition made in some central room or school. Foods, play, 'safety first,' teeth, cleanliness, sleep, fresh air, posture, etc., etc., are some of the many health topics that lend themselves easily to this form of study and portrayal. Pictures for mounting on the posters may be either furnished by the teacher or, preferably, sought out and brought in by the children. Most of the popular home magazines will be found to contain many advertisements or cover designs that can be very happily incorporated into the posters. Pencil and pen sketching is attractive work for the intermediate and higher grades, and to some extent this may be promoted successfully in the lower grades, especially if colored crayons are supplied. Lettering the titles and any other descriptive phrases which the children are inclined to add to their posters will provide excellent practice in neatness and motor control, as well as an interesting challenge to the originality and resourcefulness of the children.

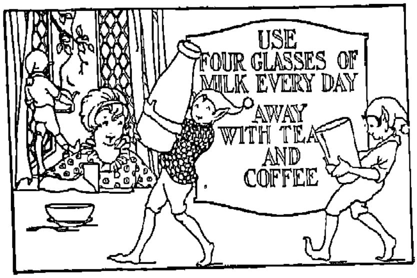

FIG. 2

A poster reminder from the New England Dairy and Food Council, Inc., Boston, Massachusetts

Other objective helps. There are a number of objective helps which teachers may employ, the more important of which are:

1. *The health bulletin board.* Not nearly enough use is made in our schools — especially in the primary and intermediate grades — of the bulletin board. In many there are none at all as yet; in many more there is only one in a corridor or hall for the general posting of announcements and notices interesting to all grades. Some progressive schools, however, have a bulletin board in every room where items of interest to the pupils in that room in particular may be displayed. No better innovation perhaps could be made by a teacher than the setting apart of a small section of wall area — it need be no larger than three feet square, although the larger the better — for this purpose. If there is danger that the thumb-tacks ordinarily used for posting may deface the wall, it is a very simple matter to secure a sheet of extra thick cardboard or beaver board the size necessary to cover the desired bulletin-board space, and fasten it at the four corners to the wall. This presents an excellent surface for posting, and the tacks used will not pierce through to the wall.

Once a bulletin board has been made available, there is no better use to which all, or the major part of it, can be put than to designate it a medium for the display of interesting news pertaining to health. A child with some cleverness at lettering may print at the top some such heading as this: "Health Notes," "Health News," "Health Club Items," "Health Bulletins," etc., etc. As these suggested titles indicate, the purpose of the board would be to display interesting items pertaining to health from the daily papers; pictures found in magazines illustrating the health lessons being studied; health posters made by the children; available pamphlets and other publications of the local or State health authorities or other public or private organizations inter-

ested in the promotion of health, etc., etc. The bulletin board may thus become a most helpful ally to the teacher in presenting constantly a variety of attractive illustrative materials in hygiene and sanitation. Editors of the board may alternate weekly around the class, or they may be elected periodically by the health club. Every pupil should be considered a reporter, always on the watch for interesting 'scoops' for contribution to the board.

2. *The hygiene scrap-book.* A delightful objective means of stimulating pupil interest in personal and community health and sanitation is to be found in the hygiene scrap-book. The covers of this may be constructed of stiff cardboard, and decorated suitably by the children. Ordinary unruled paper makes a satisfactory filling. The planning, construction, and binding of the scrap-books provide excellent opportunity for the correlation of art and handwork. The 'scoops' may consist of small drawings, jingles, sketches, and other materials made by the children, as well as clippings, pamphlets, and pictures culled from such easily available sources as newspapers and magazines, in addition to the brochures, booklets, pamphlets, etc., furnished gladly by many advertisers, business houses, manufacturers, health departments, and the like. The material may be classified beforehand, and grouped under appropriate captions in the book, such as, for example, "Colds," "Teeth," "Posture," "Foods," "Ventilation," "Flies," etc., and an index prepared at the end of the book after the project has been completed. The scrap-books will provide excellent materials for school exhibits if and whenever such chance to be held.

3. *Height and weight records.* The time is rapidly approaching when every school will possess a pair of scales for the periodic weighing of the children; many are already equipped. Where the school is not so fortunate as to own them, they can usually be borrowed. Similarly, every

school should possess a stadiometer. This can, fortunately, be readily constructed by the boys in their manual-training class. Or, if this is not feasible, approximately correct measurements may be obtained on the wall.

Periodic weighing and measuring of the pupils is one of the easiest as well as most fascinating means of directing the attention of children to the subject of their own personal health. There can hardly be found a stronger motive to induce them voluntarily to drink milk, sleep with their windows open, keep their teeth clean, eat proper food, and obey the laws of health generally.

Tables 5 and 5a show the proper height and weight for boys and for girls of average development. Copies of these tables in large poster form suitable for permanent hanging in the schoolroom, are readily available to any teacher, together with appropriate record sheets. When these are displayed conspicuously upon the wall, and the children taught to interpret them, they rarely fail to arouse those who are below weight to herculean efforts to improve their records, and to incite those who are up to weight to take a keen interest in remaining so. They provide also an objective means of convincing incredulous or thoughtless parents that there is something at fault with the nutrition of their children. For practical purposes it is ordinarily understood that a weight seven to ten per cent below the normal average indicates under-nourishment, especially in the 5–13 age groups.[1] Above thirteen years of age, a somewhat wider variation than ten per cent may be regarded as normal.

[1] It should be pointed out, however, that correct height and weight tables alone cannot be relied upon in all cases to detect poor nutrition in children. In a careful study recently reported by the New York Association for Improving the Condition of the Poor, it was found that between eighty and ninety per cent of some 4000 children studied would have been overlooked as undernourished by reference solely to these tables. Cf. *Do Height and Weight Tables Identify Undernourished Children?* Issued by the New York A.I.C.P., 1924.

Table 5. Height and Weight Table for Boys

Prepared by Dr. Thomas D. Wood and Dr. Bird T. Baldwin

These new Weight-Height-Age Tables are a revision, by Bird T. Baldwin and Thomas D. Wood, of the Wood tables formerly used. The figures represent a large group of presumably healthy children, most of whom are native born. These figures are believed to be the most accurate available.

Ht. In.	5 Yrs	6 Yrs	7 Yrs	8 Yrs	9 Yrs	10 Yrs	11 Yrs	12 Yrs	13 Yrs	14 Yrs	15 Yrs	16 Yrs	17 Yrs	18 Yrs	19 Yrs
38	34	34													
39	35	35													
40	36	36													
41	38	38	38												
42	39	39	39	39											
43	41	41	41	41											
44	44	44	44	44											
45	46	46	46	46	46										
46	47	48	48	48	48										
47	49	50	50	50	50	50									
48		52	53	53	53	53									
49		55	55	55	55	55	55								
50		57	58	58	58	58	58	58							
51			61	61	61	61	61	61							
52			63	64	64	64	64	64	64						
53			66	67	67	67	67	68	68						
54				70	70	70	70	71	71	72					
55				72	72	73	73	74	74	74					
56				75	76	77	77	77	78	78	80				
57					79	80	81	81	82	83	83				
58					83	84	84	85	85	86	87				
59						87	88	89	89	90	90	90			
60						91	92	92	93	94	95	96			
61							95	96	97	99	100	103	106		
62							100	101	102	103	104	107	111	116	
63							105	106	107	108	110	113	118	123	127
64								109	111	113	115	117	121	126	130
65								114	117	118	120	122	127	131	134
66									119	122	125	128	132	136	139
67									124	128	130	134	136	139	142
68										134	134	137	141	143	147
69										137	139	143	146	149	152
70										143	144	145	148	151	155
71										148	150	151	152	154	159
72											153	155	156	158	163
73											157	160	162	164	167
74											160	164	168	170	171

TABLE 5A. HEIGHT AND WEIGHT TABLE FOR GIRLS

Prepared by Dr. Thomas D. Wood and Dr. Bird T. Baldwin

These new Weight-Height-Age, Tables are a revision, by Bird T. Baldwin and Thomas D. Wood, of the Wood tables formerly used. The figures represent a large group of presumably healthy children, most of whom are native born. These figures are believed to be the most accurate available.

Ht. In.	5 Yrs	6 Yrs	7 Yrs	8 Yrs	9 Yrs	10 Yrs	11 Yrs	12 Yrs	13 Yrs	14 Yrs	15 Yrs	16 Yrs	17 Yrs	18 Yrs
38	33	33												
39	34	34												
40	36	36	36											
41	37	37	37											
42	39	39	39											
43	41	41	41	41										
44	42	42	42	42										
45	45	45	45	45	45									
46	47	47	47	48	48									
47	49	50	50	50	50	50								
48		52	52	52	52	53	53							
49		54	54	55	55	56	56							
50		56	56	57	58	59	61	62						
51			59	60	61	61	63	65						
52			63	64	64	64	65	67						
53			66	67	67	68	68	69	71					
54				69	70	70	71	71	73					
55				72	74	74	74	75	77	78				
56					76	78	78	79	81	83				
57					80	82	82	82	84	88	92			
58						84	86	86	88	93	96	101		
59						87	90	90	92	96	100	103	104	
60						91	95	95	97	101	105	108	109	111
61							99	100	101	105	108	112	113	116
62							104	105	106	109	113	115	117	118
63								110	110	112	116	117	119	120
64								114	115	117	119	120	122	123
65								118	120	121	122	123	125	126
66									124	124	125	128	129	130
67									128	130	131	133	133	135
68									131	133	135	136	138	138
69										135	137	138	140	142
70										136	138	140	142	144
71										138	140	142	144	145

4. *Health rhymes, jingles, and creeds.* An attractive means of interesting children in health is to be found in the making of health jingles and creeds. These should be originated by the children themselves, and may or may not be combined with pictures. Some of the best health posters the writer has seen have been combinations of pictures and appropriate rhymes.

Here is a jingle written by a fifth-grade boy:

THE A B C OF HEALTH

A stands for Apple
That grows on a bough,
B is for Butter —
I'd like some right now;
C is for Carrots:
They're good for us all;
D is for Dairy —
The milkman will call!
E is for Eggs —
Boiled, scrambled or dropped;
F is for Fruit,
And our store-man just stopped;
G is for Greens —
I like spinach best;
H is for Hermits —
Now, haven't you guessed?

Here is one of a slightly different tone. It was written by a sixth-grade child:

"Stand up," my mother tells me
When I start off to school,
"Head up! Chin in! Square shoulders!
Now don't forget that rule!"

This rhyme was illustrated with a sketch of a little girl skipping along toward school; it had been clipped from an advertisement and colored wi[illegible]

Health creeds also may be [illegible] the [illegible]

intermediate and upper grades. A contest in which all the pupils are divided into several teams, each to originate a school health creed for general adoption, is a happy means of setting all the children at work with a will. A committee of judges, to include the room teacher, the principal, and perhaps one other, may be appointed to make the final selection after all the creeds have been completed and submitted. This will not only provide opportunity for an excellent project, but will result in the general adoption of an ideal of health which can be kept conspicuously posted in the room for several weeks, until every one has memorized it and incorporated it in some reasonable degree at least into his daily living.

Here is such a creed, issued by the Massachusetts Department of Public Health:

A HEALTH CREED

FOR MASSACHUSETTS BOYS AND GIRLS

MY BODY IS THE TEMPLE OF MY SOUL

Therefore: —

I will keep my body clean within and without;
I will breathe pure air and I will live in the sunlight;
I will do no act that might endanger the health of others;
I will try to learn and practice the rules of healthy living;
I will work and rest and play at the right time and in the right way, so that my mind will be strong and my body healthy and so that I will lead a useful life and be an honor to my parents, to my friends and to my country.

ISSUED BY THE MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH

Fig. 3

Here is a physical education creed,[1] suitable for children in the junior and senior high-school grades:

[1] From *Suggestions for a Physical Education Program for Small High Schools.* Published as Physical Education Series No. 3, Bureau of Education, Washington, D.C., 1923.

A PHYSICAL EDUCATION CREED FOR STUDENTS

By Dr. A. L. Johnson, County Superintendent of Schools, Union County, N.J.

I believe my body is my house, and should be kept clean as long as it is occupied.

I believe my muscles should be kept working smoothly by regular systematic work.

I believe this training develops the will to make the best of myself and to do greater service for others.

I believe daily exercise trains me to feel and understand the joy in work and play.

I believe in athletics, in taking my part in school contests, in courage, fair play and sportsmanship.

I believe I am growing in manhood (womanhood), and am preparing myself to be an active, intelligent, useful citizen, ready to take my part and to give the other fellow a 'square deal.'

I believe in playing the game to the end, with all my mind, strength and courage.

5. *Health crusaders.* In its propaganda in the interest of health, the National Tuberculosis Association has for some years been promoting a movement in health education generally known as the Modern Health Crusade. The crusade aims to enlist the pupils of all grades, especially the fourth, fifth, sixth, and seventh, in the actual practice of health habits, the immediately tangible motive being to win honors and advancement in the several orders of the crusaders. The crusade program consists in the performance of a minimum of fifty-four health chores a week, for at least fifteen weeks. Performance of the entire list of seventy-two chores makes a perfect record. Careful entries of all scores are made, either by the pupil or by some member of his family, upon the standard score card.

The actual work for first honors in the crusade begins with the fourth grade. At the end of five weeks of successful performance, the pupil is given an enrollment certificate, and

Fig. 4. Score Card

From......................to......................192.... Name of teacher..

Daily Record

Daily Chores	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat
1 I washed my hands before each meal to-day.																					
2 I brushed my teeth thoroughly.																					
3 I tried hard to keep fingers and pencils out of my mouth and nose.																					
4 I carried a clean handkerchief.																					
5 I drank three glasses of water, but no tea or coffee.																					
6 I tried to eat only wholesome food, including vegetables and fruit.																					
7 I drank slowly two glasses of milk.																					
8 I went to toilet at regular time.																					
9 I played outdoors or with windows open a half hour.																					
10 I was in bed eleven or more hours last night, windows open.																					
11 I had a complete bath on each day of the week that is checked (x).																					

I believe that the accompanying record of health work has been correctly and honestly kept.

....

Signature of Child. *Signed by Parent or other interested person.*

Weight Record

What you should weigh....................Weight first week of this record....................Weight last week of this record....................

is duly entered as a Page. Ten weeks later, provided he has continued to meet the minimum requirements, he is made a Squire, and is awarded a Squire's button. In the fifth grade, the objective is second honors, attainment of which entitles a pupil to the rank of Knight. In the sixth grade the objective is Knight Banneret, and in the seventh Knight Banneret Constant. Winners of this exalted rank are eligible for Knights of the Round Table, membership in which inner shrine offers wide opportunities and incentives for health development and physical culture.

Much excellent material and many helpful suggestions are supplied by the Association to teachers, or by its affiliated State Leagues, bearing upon the teaching of health by the crusader method. State and National tournaments are held in which opportunities for winning pennants, cups, and other trophies are afforded. Pins, badges, ribbons, etc., awarded at strategic times, furnish appealing incentives for boys and girls to do their daily chores with a will. Hundreds of thousands of school children throughout the United States are enrolled annually in the Modern Health Crusade, and teachers are finding in the crusade method a very helpful ally in the building of fine health habits and health attitudes in boys and girls.

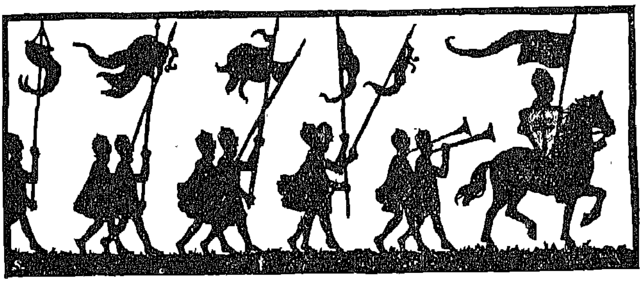

FIG. 5. A SILHOUETTE ILLUSTRATING THE MODERN HEALTH CRUSADE

(From Jenkins' *The Perfect Gentle Knight.* Copyright, 1921, by World Book Co., Yonkers-on-Hudson, New York.)

Correlation with physical education. Added interest in and appreciation of the study of health may be stimulated, especially in the children in the intermediate and junior high-school grades, by connecting very intimately with it the daily work in physical education. It should be pointed out emphatically and repeatedly to them that the fullest participation in any and all of the games, sports, and other contests sponsored by the physical director, is conditioned upon the health and vigor of their bodies. They should feel keenly the relationship between personal hygiene and physical education, and recognize fully that cultivation of the former prepares superbly for enjoyment of the latter, and *vice versa*. Often the strongest kind of motive for the formation and practice of habits of personal hygiene is the one which actuates the child so to do in order to insure membership on the 'team,' or to make a good showing in the 'meet,' contest, field day, games, tournament, or other projects connected definitely with the work in physical education. The younger children, too, will learn a valuable lesson when they are skillfully brought to realize that the health habits which they are undertaking to form or perfect will be of splendid service to them in their play, games, and drills, and in such other physical exercises as are enjoyed by them daily on the playground.

In Chapter III we shall present an outline of topics in hygiene suitable for the various grades up through the junior high school, and present some sources of supply of illustrative materials easily available for the teaching of hygiene.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Prepare a health creed suitable for the fourth grade.
2. Make a list of the fundamental health habits you believe a child ought to have well established by the time he reaches the end of the sixth grade.

3. Write the outline of a health playlet, on any subject you choose, which you think children in the second grade would enjoy dramatizing.
4. Draw up a constitution for a junior high school "Health Club."
5. Make a list of worth-while health projects which might profitably be carried out in the fifth grade; in the seventh; in the ninth.
6. Begin at once your collections of illustrative materials for future use in the actual teaching of hygiene to boys and girls. Magazine posters, advertisements, bulletins, pamphlets, and the like are exceptionally good sources for this material. All pictures should be carefully mounted. You will find large manila envelopes, alphabetically or topically labeled, excellent filing receptacles. Catalogue neatly on the face the contents of each envelope.
7. Go through all the available elementary hygiene textbooks and readers in your school library, and list them according to the grades for which they appear in your judgment to be best suited. Preserve your list, after the instructor has checked it up: it will be decidedly helpful to you some day.

SELECTED REFERENCES

1. Andress, J. M. *The Teaching of Hygiene in the Grades*, chaps. 2 and 4.
2. Cobb, Walter F. *Graded Outlines in Hygiene*. (Two volumes. Good general reference.)
3. Hoag, E. B., and Terman, L. M. *Health Work in the Schools*, chaps. 14 and 15.
4. Rapeer, L. W. *Educational Hygiene*, chaps. 25 and 26. (See also lists included in Chapter III for valuable references to pamphlets and booklets, etc., bearing upon the pedagogy of hygiene in the several grades.)
5. Storey, T. A. *Teaching of Hygiene*. In Monroe's *Cyclopedia of Education*.

CHAPTER III

A HYGIENE OUTLINE BY GRADES

The general aim in teaching hygiene. As was pointed out in the preceding lesson, hygiene must touch life if it is to be of any real value to boys and girls. Of all the subjects in the curriculum, here is the one that requires the most definitely practical and continuous contacts with actuality. We may philosophize and theorize as we will in arithmetic, or in history, or in grammar; in the hygiene lesson we must be concerned with the things that are. We may draw our problems for the former lessons from fancy or from suppositious situations if we choose: for the latter they must arise naturally and realistically from the daily experience and observation of the pupils. Precepts learned from the former may or may not have practical application in the daily work-a-day life subsequently: precepts learned from the latter must have been so embedded in the inner life and consciousness of boys and girls that they may have both the inclination and the will to govern their lives and habits in accordance with them.

What, then, is the general aim in the teaching of hygiene? It may be stated in a single sentence: to foster progressively in children while they are yet children the evolution of those habits and attitudes of health which are essential to enable them to regulate their subsequent physical lives wisely and well. This ideal of health education cannot be achieved, as we have seen, by clinging to the old traditional "physiology"; nor can it be achieved solely by dependence upon the formal medical and health inspection now periodically provided in the best schools. It can be approximated only through efficient, well-motivated, and methodical *teaching*

of health, both in its immediately personal aspect and in its wider community aspect.

The thing that teachers need to understand, then, is that the hygiene work must have the same recognized prominence in the program of the school as has been since time immemorial vouchsafed to reading, arithmetic, and language, and that precisely the same degree of skillful planning and clever motivation is essential for effectual teaching of the former that is required in good teaching of the latter.

An outline of hygiene for Grades I–IX, inclusive. In the ensuing pages there is presented an outline of topics suitable for the hygiene work of the several grades, including the junior high school. They have been selected with special reference to the stage of maturity and the psychological interests of the children concerned; and while by no means to be considered exhaustive, are suggestive to the young teacher of what can actually be done in health education in the various grades. As you study them, try to think of supplementary topics which might profitably be added in each grade-group.

HYGIENE FOR GRADES I AND II

Little Folk Hygiene

1. *Playing*
    - Play of animals:
        - The kitten, puppy, colt, calf, etc.
        - Why does Mother Nature make them playful?
    - Play of little boys and girls:
        - Favorite games.
        - Value of play for little folks.
        - How does it make one feel?
        - What kinds of play are best?
        - Under what conditions ought one to play?
2. *Rest and sleep*
    - Sleep of animals:
        - The bird, dog, cat, etc.
        - Sleep of grown-up animals and of baby animals.

Bedtimes:
When do you go to bed?
How long do you sleep?
How long do mother and father sleep?
Why does a child need to sleep longer?
How long should six- and seven-year-old children sleep?
Care of the bedroom:
Floods of sunshine during the day.
Fresh, soft air at night time.

3. *Eating*

Food and drink for the animals:
The horse, cat, cow, etc.
Food of plants and trees:
Healthy and unhealthy plants.
Food of children in other lands:
In Eskimoland, China, etc.
Food and drink for boys and girls:
Good kinds and bad kinds.
Cleanliness of foods and dishes.
What food does for us.
Table manners.

4. *Clothing*

Mother Nature's clothing for the animal:
The cat, dog, lamb, bird, etc.
Clothing worn by children of other lands:
The Indian child.
The Eskimo child.
The Dutch child.
The Japanese child.
Clothing for boys and girls:
Kinds for warm weather.
Kinds for cool weather.
Kinds for cold weather.
Day clothes and night clothes.
Care and cleanliness of clothing.

5. *Cleanliness*

Of animal pets.
Of attractive people generally.
Of boys and girls:
Hands, face, skin, nails.
Ears and nose.

Hair and scalp.
Teeth.
Clothing and shoes.
The bath.
In the schoolroom.
In the school yard.
On the streets.
At home:
What can little folks do to help?

The following personal habits should have become so fixed by the end of the second grade as to give reasonable evidence of permanency:

1. Clean hands, face, ears, and skin to start the day with.
2. Frequent cleansing of the exposed skin.
3. Nails trimmed and in good condition.
4. Scalp clean and hair brushed.
5. Teeth brushed and mouth in good condition.
6. Wearing neat, clean clothing.
7. Carrying a clean handkerchief and using it when needed.
8. Love of wholesome play in the open.
9. Fresh-air habits.
10. Wise elementary food habits.

Methods and motives. Careful morning inspections conducted by the teacher afford the best means of daily checking up upon many of the habits above enumerated. The children should understand that the purpose of the inspection in these grades is to encourage them and help them to keep clean, rather than to afford the teacher a means of keeping records of their individual shortcomings. Health stories are always full of interest for little folks, provided they are well told. Simple blackboard maxims and precepts may be profitably kept before the children, if they are changed frequently. Occasional toothbrush drills will be an important means of demonstrating proper use of the toothbrush. Easy bits of dramatization are always eagerly participated in. The constructive, manual, and play instincts

may be appealed to with profit, as may also the instincts of curiosity, emulation, and others. The natural interest which little folks ordinarily have in animals may also be turned into good use. Simple posters illustrative of health matters may be cut out, decorated, and mounted. Periodic weighing and measuring may be conducted where facilities are available. "Psychological moments" should be seized whenever they arise to impress health lessons upon the receptive minds of little people, regardless of whether they occur during formal hygiene periods or not. It is not infrequently incidental teaching of this sort, particularly in the lower grades, that is fruitful of the best results.

HYGIENE FOR GRADES III AND IV

Habit Hygiene

1. *Proper food habits*
    - The morning meal.
    - The lunch at noon:
        - At home.
        - At school.
    - The evening meal.
    - Wholesome and unwholesome food and drink in general:
        - Fresh foods.
        - Clean foods.
        - Well-cooked foods.
        - Pure water and milk.
    - Milk as an indispensable food.
    - Tea and coffee to be avoided by boys and girls.
    - Relation of food and drink to health.
    - Eating between meals.
    - Care of dishes and food containers.
    - Brushing the teeth.
    - The common cup.
    - Happy meal times.
    - Good table manners.
2. *Proper fresh-air habits*
    - Need of pure air.

Lack of pure air in homes.
Foul air in street cars, stores, theaters, etc.
Outdoor play and sports:
  Indoor and outdoor plants.
  Walk rather than ride whenever possible.
Breathing habits.
Keeping the schoolroom ventilated.
Ventilating the bedroom and the living-room.
The 'night air' bugbear.

3. *Proper temperature habits*
The thermometer.
Overheated schoolrooms.
Overheated residences.
Clothing for summer time.
Clothing for spring and fall.
Clothing for winter.
Colds:
  Why common in cold weather?
  How spread at school?
  What can children do to protect one another?
  Care of colds important.
  Training the skin to be vigorous.

4. *Proper posture habits*
Some reasons why boys and girls should be straight and strong.
Why we have adjustable seats and desks.
The correct standing posture.
The correct sitting posture.
Posture while working and playing.
The correct way to walk.

5. *Proper exercise habits*
Play and health.
Play and happiness.
Children who never play:
  Crippled children.
  Unwell children.
Excellent types of play:
  Swimming, rowing, coasting, running, skating, etc.
Plays and games of children in other lands.
Fairness in play.
Avoidance of roughness in play.

Proper places to play:
    Avoidance of streets, railroad yards, wharves, etc.
A time to play and a time to work.
Play out of doors whenever possible.

6. *Proper habits of cleanliness*
    Bathing:
        The warm bath.
        The cold bath.
    Clean thinking and acting and speaking.

7. *Avoidance of disease*
    Importance of personal hygiene.
    Common causes of the spread of contagious diseases:
        Bad ventilation.
        Crowded rooms, cars, etc.
        Common utensils, etc.
        Careless habits.
        Spitting, coughing, etc.
        Poor bodily health.
    What can children do to guard their health?
        In the schoolroom.
        Among people.
        At home.
    Responsibility of each for the health of all:
        In the school.
        In the home.
        In the community.

8. *Care of the eyes and ears*
    Importance of all our senses.
    Special importance of our eyes
    The proper way to read.
    Rubbing our eyes.
    Straining our eyes.
    Cleanliness and protection of our ears.

Methods and motives. In the third and fourth grades, provided it has been systematically done in the two preceding grades, the daily morning health inspection may be dispensed with, save on occasion. It should still be held periodically, however, as a means of checking up on the permanence of the fundamental personal health habits formed during the primary years.

Among the most fruitful instinctive tendencies to which the teacher may appeal in these grades are those of emulation and rivalry, by row, class, or team; pride; approbation; curiosity; manual activity; etc. The soldier interest is strong at this age, and may be enlisted as an ally in the teaching of such topics as posture, exercise, and cleanliness. Poster work is very effective, provided the children plan and execute largely for themselves. Dramatization may be made effective use of in connection with practically all the health topics in these grades. The "Health Chores" in the crusader movement are stimulating reminders to the children of the importance of careful daily practice of those habits about which they learn in the hygiene lessons.

Stories illustrating self-evident truths about health have never more fascination than at this age, and can be readily manufactured by most teachers. There are already on the market several excellent health readers containing interesting and well-illustrated stories appropriate for young primary and intermediate children. The imagination of pupils at this age is vivid, and their ability to envisage and dramatize situations thus presented is no less keen than is their capacity to understand and enjoy them. Demonstration and simple experimentation can often be introduced effectively by the time the fourth grade is reached. The capacity of children to observe with some fair degree of accuracy may be taken for granted, and simple projects which bring into use the exercise of this growing power may be undertaken in both these grades.

HYGIENE FOR GRADES 5 AND 6

Home and School Hygiene

1. *Sweeping and dusting*
   Hygienic *versus* non-hygienic methods.
   The nature of dust.

The effect of dust upon our organs.
The broom.
The feather duster.
Dust-absorbers.
Oil dusters and mops.
Care of furniture and hangings.
Care of floors and woodwork.

2. *Foods*
Functions of food.
Importance of a mixed diet.
Good and bad menus:
Construction of good menus.
The selection of foods
Economy in foods.
Decaying foods.
Cold storage of foods:
Use and abuse.
Common adulterations.
Care of food products in stores, markets, etc.
Refrigeration and care of foods in the home.
Effect of heat upon milk.
Home-made refrigerators, coolers, milk shelters, etc.
Cleanliness of all food containers.
Proper cooking of food
Food habits.

3. *Milk*
Milk for the kitten.
Milk for the baby.
Milk as a food.
Milk for everybody.
The economy of milk.
Clean milkmen and safe sources of production.
Careful distribution of milk.
Care of bottles and other containers.

4. *Water*
Sources for school, home and city.
The common drinking-cup.
Proper use of bubblers and fountains.
Watering places for animals.

5. *Garbage and wastes*
Garbage buckets:
Care and cleanliness.

Scavenger departments.
Proper disposal of waste papers and rubbish.
The fire hazard.
Duties and responsibilities of the family.
Public refuse baskets.
Care of public parks, streets, and grounds.

6. *Flies, mosquitoes and other disease-carrying insects*
   Life history of the fly.
   Life history of the mosquito.
   Means of extermination.
   Extermination contests.
   Economic importance of these insects.
   Common diseases spread by them.
7. *Infectious and contagious diseases*
   The common 'children's diseases':
      Mumps, measles, scarlet fever, diphtheria, etc.
   Known modes of infection.
   How diseases are ordinarily spread (simple and non-technical).
   Vaccination and other safeguards and preventives.
   Opposition to inoculation:
      Due to ignorance or prejudice.
      Special study of the conquest of small-pox.
   How to escape 'colds' during the winter months.
   Precautions to be taken by those suffering.
   Quarantine and isolation.
8. *Clean yards*
   At home.
   At school.
   Duties and responsibilities of children.
   'Clean-up' campaigns.
9. *Comfortable rooms*
   Proper ventilation.
   Proper heating and humidifying.
   Proper lighting.
   Sunshine.
   Fresh air.
   General cleanliness.
   Flowers and tasteful decorations.
   Comfortable homes.
   Comfortable schoolrooms.

10. *Safety First*
    - Wastage of human life:
        - Child and adult.
    - Local accident statistics:
        - Chief causes.
        - Avoidance of accidents:
        - Crossing streets.
        - Boarding and leaving cars.
        - Riding wagons, carts, trucks, etc.
        - Playing in the street.
        - Frequenting private railroad property.
        - 'Taking chances.'
        - The poison label.
        - Broken wires.
        - Careless use of matches, fire, etc.
        - Coasting.
    - The children's good friend: the policeman.
11. *First Aid*
    - Importance of knowing what to do in an emergency.
    - Fainting.
    - Bleeding:
        - Nose.
        - Wounds.
        - Vein.
        - Artery.
    - Bruises.
    - Burns.
    - Sprains.
    - Broken bones.
    - Something in the eye.
    - Poisons:
        - Internal.
        - Skin.
    - Shock.
    - Drowning.

Methods and motives. The children in grades five and six are in the midst of the age of curiosity and the dawning social consciousness. The methods of vitalizing the work in hygiene in these grades will be determined accordingly.

Opportunity to observe something of the nature of bacteria should be given them in order that they may learn the more fundamental principles of disease and contagion. Problems and contests in fly and mosquito extermination will prove fruitful of results. Some simple experimentation with foods, food values, and preservation will be both interesting and profitable. Time and facilities for experimentation are ordinarily extremely limited, however, in the crowded curricula of our schools. The most practicable methods of giving instruction in matters of health and sanitation will be for these grades, as for those preceding them, extensive observation and reports and wide parallel reading and discussion. Some supplementary home projects in ventilation, *cleaning, waste disposal, food care and preparation, etc.,* may be profitably carried on, and the environment of the school itself affords much excellent opportunity for applying to concrete situations most of the facts learned from day to day in connection with the hygiene topics of these grades. The individualistic instincts of rivalry, curiosity, inventiveness, constructiveness, etc., and the social instincts leading toward dramatization projects and group activities of various sorts should be constantly taken advantage of. Demonstrations and exhibits of health themes may be planned occasionally. Health scrap-books lend interest and often enthusiasm to the search after hygiene materials. Poster work of a more artistic nature than heretofore can be done in these grades, and the health bulletin board will be indispensable.

HYGIENE FOR GRADES 7, 8 and 9

Community Hygiene

1. *Interdependence in a social democracy*
   - Relationship between personal hygiene and the public health.
   - Relationship between home and school hygiene and the public health.
   - Health as a social and moral obligation.

2. *Boards of health*

Duties and importance.

Rules and regulations of the local board regarding the public health.

Membership on the local board.

Some of its routine activities.

Its several divisions.

Necessity for the coöperation of all good citizens with the board.

Activities of the State board of health:

Exhibits of some of its best publications, pamphlets, etc.

Annual cost of keeping the health of the community safeguarded.

3. *Local disease*

Study of local vital statistics.

The most prevalent local causes of death.

Graphic comparison of local disease incidence with that for the State and Nation.

Study of possible common causes or sources of some of these local diseases:

Crowded and overheated cars.

Theaters.

Stores.

Carelessness of health regulations.

Other sources of illness in cold weather.

In warm weather.

The great white plague:

Story of its gradual but sure conquest.

Wise rules for its prevention and control.

Graphic representation of the decline in death-rate.

Relationship of poor nutrition to tuberculosis.

4. *Hospitals and sanatoria*

Their value to individuals.

Their indispensability to the community.

Census of capacity of local institutions.

Special neighborhood or near-by hospitals:

Tuberculosis.

Isolation.

Insane.

Public clinics and dispensaries.

5. *Street cleaning, sprinkling, and snow-removal*
    Importance of sanitary streets to health and comfort.
    Street-cleaning equipment of the local department.
    Some improved methods.
    Street care in continental centers.
    Responsibilities of the abutter:
        In keeping his section of the sidewalk clean and free from snow.
    Total aggregate length in miles of the local streets:
        Annual cost of upkeep.
        Relative cost of streets, health, police, etc.

6. *Parks and playgrounds*
    Value of recreation grounds to a city:
        In money.
        In health.
        In attractiveness.
    The right of children to play.
    Surveys and mapping of local parks and playgrounds.
    Equipment and management.
    Beauty an asset to individual and community life.

7. *Housing conditions*
    The rights inalienable of every family:
        To fresh air.
        To sunshine.
        To green grass.
        To a garden plot.
    Overcrowding in the poorer sections.
    Study of local conditions.
    Our duties to the immigrants in the foreign quarters:
        Social undesirability of unassimilated persons.

8. *Public buildings*
    Ventilation, plumbing, etc.
    Safety.

9. *Public markets*
    Cleanliness.
    Condition of foods offered for sale.
    Foods exposed to insects, dust, etc.
    Promiscuous handling of foods by patrons.
    Careless handling of foods by clerks.
    Appearance and habits of clerks.
    Care of meats and perishable foods.

Outdoor markets and food vendors:
Necessity for careful washing of fruits thus purchased.

10. *Industrial and factory hygiene*
Rights of the working man to reasonable protection:
From disease.
From accident.
Accident and disability insurance.
Survey of local industrial plants and the work done by them to conserve the health of their employees.
Visit to one or more of the first-rate plants.

11. *Dumps*
Surveys and reports of all local dumping tracts.
Rules and regulations regarding their care and use.
Abuse of dumps.
Back-yard 'dumps.'

12. *Fire protection*
Dangers from great conflagrations.
Economic wastage from fires.
Destruction of timber and woodland.
Carelessness in the use of fire.
Principal causes of fires.
Local preventive facilities:
Equipment of the department.
The fire-fighting force.
The fire-alarm signaling system.
How to 'ring in' an alarm.
Loss through local fires during preceding twelve-month.
Dangers from papers and rubbish in basements, etc.
Importance of building laws; inspection of wiring, plumbing, etc.

13. *Sewage disposal*
Dangers from sewage improperly reduced.
The sewers of Paris (Cf. *Les Miserables*).
Study of local methods of reduction or disposal.
Study of ideal methods.
Importance of plumbing, traps, etc., in the home.

14. *Garbage disposal*
Necessity for coöperation on part of every family.
Study of local methods of collecting and disposal.

15. *Water supply*
Principles of storage and filtration.

Visit to local or near-by reservoirs.
Essentials of a good system.
Importance of safeguarding all preserves.
Location of mains, service pipes, etc.
House filters.
Public drinking-fountains.
Diseases transmitted by impure water.

16. *The fly problem*
    Its importance:
        Economic.
        Hygienic.
    Life history of the fly.
    Diseases carried by the fly.
    Survey of local stables and other breeding places.
    Methods of extermination and control.
    Construction of fly-traps.
    The responsibility of the home.

17. *The mosquito problem*
    Mosquitoes both a nuisance and a menace.
    The conquest of the mosquito in tropical countries:
        In the Italian marshes.
        In the Canal Zone.
    Survey of local breeding places.
    Common back-yard breeding places.
    Means of prevention and control.

Methods and motives. The purpose of the work in hygiene in the junior high-school grades should be to create in the child a strong and growing interest in the problems of neighborhood sanitation and health. The pupils in these grades have passed fairly beyond the age of individualism into the age of socialism. It is this fact of psychological development which affords us a proper orientation for interesting young adolescents in the broader problems of citizenship. The viewpoint and emphasis now become altruistic, civic, communal. While obviously the work during the preceding grades has been largely self-centered and individualistic, the child's mind during this age is opening outward, and the

time for real constructive work in training for future good citizenship is at hand. The earlier instruction in personal hygiene has resulted in certain fundamental habits being formed; civic sympathy and appreciation now burst forth. This does not mean, however, that the earlier work in personal, home and school hygiene is to be entirely given up. Children in the junior high-school age will still be in need of personal health education, and provisions should be made for systematic study of personal hygiene, based upon a minimum of physiological and anatomical discussion and demonstration, to parallel the new work in community hygiene and sanitation. A good text should be made available for this work. It will be found interesting to have these lessons in personal health culture alternate with those in community health and sanitation.

The important aim in hygiene in these grades, however, is, as we have seen, to bring home to the pupils — most of whom will never receive further systematic education — the great lesson of coöperation in matters pertaining to the public health. To this end, any method that will encourage and promote an attitude of personal responsibility in the pupils should prove an admirable one. Among such methods may be mentioned the surveying of local public markets, buildings, dispensaries, theaters, factories, etc.; the study of taxation and the apportionment of its funds to the public health work; trips to near-by filter-beds, reservoirs, and preserves; the judging of local markets in percentages according to a prearranged scale; the comparison of local and State vital statistics; the organization of school boards of health, hospital staffs, city governments, traffic directors, etc.; and the frequent use of slides, films, exhibits, and other illustrative materials. For the junior high-school grades, more than any that have preceded them, the community should be made the laboratory where continuous and systematic

study of health-disease factors and situations is carried on. Constant use of the textbook in community hygiene should be provided for, as should also opportunity for a study of yeasts and molds as related forms of bacteria, to the end that the general principles of infection may be the better understood.

Excellent opportunity for correlation with the elementary science, manual training, art, mathematics, English, and other departments is offered by the nature of the hygiene work in the junior high-school grades. Team and group work may most profitably be organized for the children in these grades, and problems and projects thus undertaken will yield the highest returns in actual training, as well as in the amount of interest and effort put forth in their solution. Socialized recitations, theme writing, investigation of special topics and projects, health-club organizations, debates, preparation of balanced menus, analysis of lunches brought by children, personal health charts, special health weeks and drives, etc., not only will be found helpful in adding interest to the study of hygiene, but also in developing in the minds of young adolescents a real health consciousness that should go with them after their school days out into their every-day life and work.

The psychological moment. In the preceding course of study, as outlined, there is necessarily much overlapping from year to year. Real teaching of hygiene to boys and girls is so largely determined by incidents and "psychological moments" that any suggested outline or procedure must of necessity not only lack strict coördination and progressiveness, but also be sufficiently elastic to permit a considerable degree of manipulation and adaptation. Thus, it would not be wise to discontinue the regular morning inspections completely with the beginning of the third grade. Nor could the emphasis upon correct posture in grades three and

four be expected to result invariably in such permanent and complete formation of these habits that no further attention need be paid to them in subsequent grades. Again, it would be a serious mistake to delay all instruction in the problems of community sanitation until the seventh grade.

The skilled teacher will be always on the lookout for the psychological moment for driving home a health truth. For example, if a rural teacher had planned to devote the first meeting of the hygiene club in March to a discussion of the common drinking-cup, it would be an unfortunate error for her to overlook instances of two or three children drinking from the same dipper in the first week in November. Or again, if her program called for first-aid demonstrations during the last week of April, it would be equally unpedagogical for her to permit a boy on the playground to bandage a cut finger or a bruised arm with a dirty handkerchief two weeks or even two days before that date. The time to strike in health situations, as in all others, is when the iron is hot!

Sources and materials for the study and teaching of hygiene. There are a number of easily available sources that may be utilized by the teacher. The more important of these are:

1. *Pamphlets, circulars, etc.* The number of excellent pamphlets and circulars available for the hygiene teacher is not only very large, but it is increasing rapidly. In the list below no attempt is made to exhaust the materials of this sort. The titles presented are among the best and most easily available, however. In addition to these, the State Board of Health, the State Division of Hygiene, the State Department of Education, and the State and National Departments of Agriculture are in most instances ready to supply gratis a considerable assortment of their own publications especially intended to aid teachers in the dissemination of information regarding health, and in the building up

of permanent attitudes and a lively health consciousness in the school child.

1. *Publications of the United States Bureau of Education.* (These may be procured from the Superintendent of Documents, Government Printing Office, Washington, D.C. The charge is in most cases five or ten cents for the first copy and from one to four cents for each additional copy.)

   Health Education Series

   1. Classroom Record of Weight.
   2. Wanted! Teachers to Enlist for Health Service.
   3. Diet for the School Child.
   4. Summer Health and Play School.
   5. Teaching Health.
   6. Child Health Program for Parent-Teacher Associations and Women's Clubs.
   7. Further Steps in Teaching Health.
   8. The Lunch Hour at School.
   9. Health Training for Teachers.
   10. Your Opportunity in the Schools.
   11. Suggestions for a Program for Health Teaching in the Elementary Schools.
   12. Milk and Our School Children.
   13. Sleep.
   14. Dramatics for Health Teaching.
   15. The Kindergarten and Health.
   16. Suggestions for a Program for Health Teaching in the High School.

   School Health Studies

   17. Health for School Children.
   18. The Child Health School in the University of Chicago.
   19. Who's Who in Health Land.
   20. Growing Healthy Children.

2. *Publications of the Metropolitan Life Insurance Company*

   21. All About Milk.
   22. Care of the Teeth.
   23. Magic Health Booklet.
   24. How to Live Long.
   25. Mother Goose Postal Cards.
   26. Who Loved Best.
   27. Whooping Cough.
   28. Diphtheria.

2. *Books.* Below are presented a considerable number of titles of some of the best books available as readers or as texts in hygiene, and suitable for children of the grades indicated. The list is by no means complete, since it is being added to monthly by reputable and competent writers in the field of health, but it contains many representative titles that may be relied upon to furnish an excellent basis for the classroom study of personal and community hygiene. The grades for which each book listed is designated as best adapted were assigned in most cases by the present author, and while it cannot be said that any one of them is adapted solely to any single grade, it will be found that the bulk of a given book will lend itself very nicely to the particular grades indicated.

For Grades under the Fifth

1. Coleman, Walter M. *A Health Primer.* 189 pp. (Macmillan.)
2. Gulick Hygiene Series. Book 1: *Good Health.* (Ginn.)
3. Woods Hutchinson Health Series. *The Child's Day.* 183 pp. (Houghton Mifflin Co.)
4. Woods Hutchinson Health Series. *Building Strong Bodies.* 250 pp. (Houghton Mifflin Co.)
5. Hutchinson's Modern Physiology, Hygiene, and Health Series. Primer: *The Most Wonderful House in the World.* 204 pp. (Lippincott.)
6. Same, Book 1: *The Play House.* 196 pp.
7. Jones, May Farinholt. *Keep Well Stories for Little Folks.* 140 pp. (Lippincott.)

For Grades 5 and 6

8. Bigelow, M. A., and Broadhurst, J. *Health for Every Day.* 235 pp. (Silver, Burdett and Company.)
9. Brown, Bertha M. *Good Health for Boys and Girls.* 152 pp. (Heath.)
10. Cobb, W. F. *Chalk Talks on Health and Safety.* 243 pp. (Macmillan.)
11. Gulick Hygiene Series. Vol. 2: *Emergencies.* (Ginn.)
12. Same, Vol. 6: *The Body and Its Defenses.*

13. Woods Hutchinson Health Series. *Community Hygiene.* 310 pp. (Houghton Mifflin Co.)
14. O'Shea and Kellogg Health Series. Vol. 2: *Health and Cleanliness.* 301 pp. (Macmillan.)
15. Same, Vol. 1: *Health Habits.* 216 pp.
16. O'Shea and Kellogg Everyday Health Series. Book 1: *Building Health Habits.* 280 pp. (Macmillan.)
17. Same, Book 2: *Keeping the Body in Health.* 311 pp.
18. Overton, Frank. *Personal Hygiene.* 240 pp. (American Book Co.)
19. Overton, Frank. *General Hygiene.* 377 pp.
20. Winslow, C.-E. A. *Healthy Living.* Book 1. 248 pp. (Merrill.)

For Grades 7, 8, and 9

21. Bigelow, M. A., and Broadhurst, J. *Health in Home and Neighborhood.* 320 pp. (Silver, Burdett and Company.)
22. Bussey, G. D. *A Manual of Personal Hygiene.* 156 pp. (Ginn.)
23. Coleman, Walter M. *A Handbook of the People's Health.* 307 pp. (Macmillan.)
24. Gulick Hygiene Series. Vol. 3: *Town and City.* (Ginn.)
25. Same, Vol. 4: *The Body at Work.*
26. Same, Vol. 5: *Control of Body and Mind.*
27. Woods Hutchinson Health Series. *The New Handbook of Health.* (Revised and Enlarged Edition, 1926) 399 pp. Houghton Mifflin Co.
28. Keith, Arthur. *The Engines of the Human Body.* 284 pp. (Lippincott.)
29. O'Shea and Kellogg Health Series. Vol. 3: *The Body in Health.* 324 pp. (Macmillan.)
30. Same, Vol. 4: *Making the Most of Life.* 298 pp.
31. Ritchie, John W. *Primer of Sanitation.* 196 pp. (World Book Co.)
32. Ritchie and Caldwell. *Primer of Hygiene.* 184 pp. (World Book Co.)
33. Winslow, C.-E. A. *Healthy Living.* Book 2. 405 pp. (Merrill.)
34. Burkhard, W. E., Chambers, R. L., and Maroney, F. W. *Health Habits.* Vol. 2: *Physiology and Hygiene.* 432 pp. (Lyons and Carnahan.)

CHAPTER IV

THE SKIN AND ITS DERIVATIVES

1. *Structural approach*

The epidermis. We shall begin our study of the human organism with its outermost covering, the skin, and pass from thence inward into the fascinating interior. What in popular speech is called the 'skin' is in reality only the outer portion of the body mantle, and is anatomically known as the epidermis (*epi*, 'upon,' and *derma*, 'skin.' Structurally the epidermis is made up of a dozen or more layers of epithelial cells dove-tailing into one another like stones in a wall, and securely fastened together by Nature's own cement. The lower layers of these epithelial cells are kept alive by the lymph, but the superficial layers are too far removed from the dermis to receive the lymph ooze; these outer cells are consequently dry and lifeless, and are continually being pushed off by the multiplication of new cells beneath.

This shedding of our skins (desquamation) is helped along by any friction which chances to be set up against the surface of the epidermis, as for example that caused by the rubbing of our clothing against it, by manual work of any sort, by bathing, and even by a brisk breeze blowing upon it. On the scalp these dead cells or scales become enmeshed in the hair, and are often so plentiful as to be visible to the eye as dandruff. It is interesting to watch this process of desquamation as it takes place around a deep wound or sore over which a scab has formed. Little by little, as the tireless cells deep down in the dermis push their way upward, the ring of scab becomes narrower and narrower until in due time it is pinched off quite, and a new mantle of flawless

epithelium has replaced what a few days before was an unsightly and painful blemish upon the skin.

The chief function of the epidermis is to protect, by means of its horny outer layers, the very delicate true skin, or dermis, lying underneath. As fast as it wears out, Nature replaces it from below; if it is bruised or torn away by accident she hastens to join the wounded parts together, thus seeing zealously to it that the vital dermis is shielded continually from the possibilities of infection and injury from without. These epithelial cells contain no blood-vessels; hence merely pricking through the outer skin will not cause bleeding. They contain no nerves, hence cannot register pain. Boys very often like to make their girl observers feel 'creepy' by gathering up folds of their outer skin into puckers with pins or needles, and presenting to the gaze of the girls veritable pin-cushioned hands! You may be sure they would not resort to this means of showing off if the process were in the slightest degree painful.

Deep down in the lowest polygonal layers, the epithelial cells contain an interesting pigment composed of very minute particles of coloring matter. Some of your friends are of the 'blond' type; others are of the 'brunette.' The former, the blonds, have relatively small amounts of pigment grains in these cells; the latter, the 'brunettes' have pigment grains in relative abundance. It is also due to the amount of pigment in these cells that races derive the color of their skins. In tropical regions the effect of generations of glaring sunlight upon pigment cells is seen in bronzed or dusky skin. Even in temperate regions during the summer months we find our skins becoming much darker than they were in winter, when the sun's rays were too feeble to stimulate the pigmented cells to vigorous activity.

In some individuals the pigment cells are inactive, even under the influence of the summer sun. Their skin and hair

are white, and their eyes, lacking pigment also, are a pale pink. Such people are known as 'albinos' (Latin: *album*, white). In still other individuals the pigment in adjacent cells is present in excessive quantities, and under the stimulating influence of sunshine and wind these become overactive, resulting in tan and freckles, and occasionally manifesting themselves in 'liver spots' or 'moth patches.'

The dermis. But after all, the true skin is not the epidermis, which we see; it is the dermis, which we do not see save when we have knocked off or torn away a bit of the former. From the appearance of the epidermis we should be inclined to infer that the surface of the dermis is likewise smooth and even. Such, however, is not the case. If we could by some painless operation lift a section of the epidermis from the dermis and make an examination of the true skin beneath, we should find that it was rough and uneven, not unlike a miniature mountain range, with valleys and ravines running in among the peaks. These peaks or hillocks are called the "papillæ" of the dermis. The lower cells of the epidermis fill in the ravines of the dermis so neatly that the papillæ cannot usually be detected through the outer skin. They may be seen, however, on the palm of the hands and the ends of the fingers. Figure 6, *A*, shows the papillæ of the dermis projecting up into and among the lower layers of the epidermis above.

Within the papillæ are two important organs, the dermal nerve endings and the blood tubes. The former of these, the nerves, are of at least four distinct kinds, those reacting to stimuli of warmth, of cold, of touch, and of pain. The specific nature of these end-organs is noteworthy: the temperature nerves, usually called the "warm spots" and the "cold spots," responding only to heat stimuli and cold stimuli, respectively; the pressure spots, responding to touch sensations primarily, *e.g.*, smooth, rough, even, soft, etc.;

and the pain end-organs, reacting only to intense and forceful stimuli.

The blood vessels of the skin lie in a network throughout the dermis, extending upward into the papillæ. Their function is, of course, primarily to supply food and oxygen to the dermal and lower epithelial cells. They are also supplied, as we shall see in a later paragraph, with muscles which aid in the control of the body temperature. These vessels are so numerous throughout the dermis that we cannot push a needle through at any point without rupturing one of them and releasing a drop of blood. Figure 6, *F*, shows the dermal nerves in the papillæ; *D* shows the blood vessels.

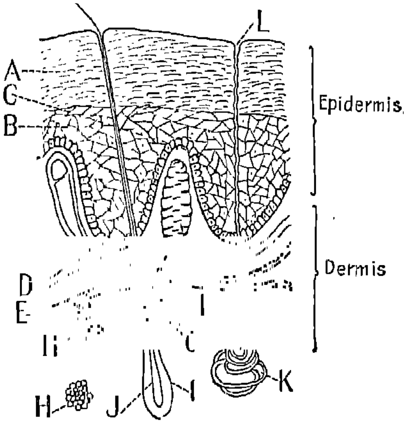

FIG. 6. A DIAGRAMMATIC SECTION OF THE SKIN

A, Flattened outer cells of the epidermis; *B*, cells of the lower epidermis, *C*, a papilla; *D*, a blood vessel; *E*, a nerve; *F*, a touch corpuscle; *G*, oil gland; *H*, fat cells; *I*, hair follicle; *J*, hair; *K*, sweat gland; *L*, pore.

The regulation of body temperature. The optimum room temperature for comfort is known to be somewhere between 65° and 70° F., and heating and ventilating engineers recognize it as one of their most difficult problems to provide homes, office buildings, schools, etc., with a heating and ventilating system that will maintain this recognized standard with anything like reasonable accuracy. In our homes, in cold weather, we are continually regulating the heating plant and manipulating the windows, doors, and ventilators

in an endeavor to keep the rooms comfortable. Bearing in mind all this outlay of time and effort, and the often highly unsatisfactory results obtained, we must marvel indeed at the precision with which Nature regulates the temperature of our body homes. The temperature out-of-doors may vary anywhere between 25° below zero and 110° above zero; within doors it often varies anywhere between 45° above zero and 90° above zero. But the temperature within the human body must vary only one or two degrees from one year's end to the next. Summer or winter, day or night, mid-day or dusk, working or resting, it hovers about 99° F., never in health appreciably dropping below or rising above that point.

How is it done? Before we can answer this question we shall have to study Figure 6, *K*, a sweat gland, or perspiratory gland. It will be observed that this gland is, in effect, a small coiled tube lying in the dermis and sub-cuticle fat, and surrounded by a network of capillaries. The duct leading from the gland passes upward through the dermis and opens upon the surface of the dermis in the form of a pore. Now suppose one is engaging on a warm but breezy day in some moderately vigorous exercise, such, for example, as playing a game of tennis. To the observer, the fact that beads of perspiration are standing upon the player's forehead indicates that he is "warm." And so he is. But why does perspiration ooze out of his pores, and how does the process regulate body temperature? From the flushed cheeks of the player, it appears also that more blood is being pumped to the surface of his body than is the case with the spectator of the match, who may actually feel chilly. This routing of a greater volume of blood to the dermis and the greater activity of the perspiratory glands coöperate in maintaining the 99° F. temperature of the player's body. By dilation of the skin vessels and the consequent circulation of more blood

through them, much of the excess heat generated by the activity of the muscles is radiated from the body, exactly as the heat from a hot-water plant is thrown off by the radiators or steam coils.

As we shall learn later, the process of metabolism within the cells of the body results in throwing off into the blood certain katabolic poisons which must be gotten rid of as rapidly as possible if the efficiency of the organism is not to be impaired. The tennis player, by reason of his strenuous activity, is burning up in his muscle cells more food than is the spectator, and his blood is in consequence charged more heavily with the waste products of oxidation. Some of these he throws off through the lungs; others of them, borne along as they are in the blood stream, reach the skin vessels, which are dilated to receive them. At the capillaries surrounding the sweat glands large amounts of these wastes are absorbed into the glands in the form of water, salt, and other solids. These are promptly excreted upon the surface of the skin by the perspiratory ducts, and there, as the air comes in contact with them, the watery portion is evaporated, leaving the solids in deposit upon the skin. Thus does the body lose heat through evaporation as well as by radiation, the amount of heat lost through either means being determined by and conditioned upon the excess amount of heat released in the body by muscular activity.

As every one knows, there are certain climatic or environmental conditions under which the cooling of the body through evaporation of sweat cannot take place effectively. People who live in dry regions are apt to suffer less from summer heat than those who live in damp or rainy regions, since the rate of evaporation is more rapid. On a sultry, "muggy" day, when the temperature is high and there is no air in circulation, muscular activity is particularly irksome. The heat draws the blood to the surface in abundance, but

when the perspiration extracted from it by the sweat glands is poured out upon the surface of the skin there is no means of evaporating it. In such circumstance, to be alive is almost a burden, and with what welcome does one acclaim the approaching thunder shower, with its gusts of wind fanning the vainly perspiring body!

In cold weather, excessive loss of heat from the body is prevented in the same way, except that the dermal blood vessels are now contracted and the blood stream is routed in much smaller volume through them. Thus, with the blood deeper in the tissues, there is relatively little extraction at the sweat glands, and the minimum of heat is lost. The blood is kept warm in the deep interior of the body. Perhaps the greatest marvel of it all is that this control of body temperature is entirely automatic and self-regulative: we have no voluntary control whatever over it, and it is next to an impossibility to place a healthy body either under conditions of excessive heat or excessive cold that will be sufficient to raise or lower its internal temperature more than a degree or so above or below its customary level. It has been found experimentally that a surrounding temperature of more than 150° F., can be withstood without discomfort, and without raising the internal temperature more than a single degree. The interior of man is not unlike the interior of a thermos bottle: uninfluenced by the temperature of the surrounding medium, although of course the temperature is maintained at its constant level by a wholly different principle from that which operates in controlling the inner temperature of the thermos bottle.

The hair. Embedded deep in the papillæ of the dermis, and in some cases reaching down into the sub-cutaneous fat cells are the hair pits, or hair follicles. Structurally, these pits are slight inversions of the dermis, forming tiny sockets. The hair itself consists of a column of epithelial cells which

are pushed up from the root in the follicle as new cells are formed beneath them. Like the epidermis, the outer, visible layers of cells comprising a hair are dead cells; growth takes place at the root only, the cells lying in the follicle being living cells, multiplying in the same way as the cells of the dermis. The hair is, therefore, not to be thought of as a unique type of organ: it is merely a specialized form of epithelial cell, and is properly classifiable, like the nail, as a derivative or appendage of the skin. The color of the hair depends, like that of the skin also, upon the presence of pigment in certain of the cells comprising it.

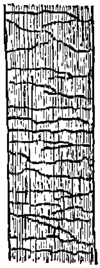

FIG. 7. PIECE OF HUMAN HAIR
Shown highly magnified.

Functionally, the hair serves to protect the head, especially from injury and from the force of the sun's rays, as well as to aid in keeping the body warm. Animals depend entirely for warmth upon the thickness of their hairy coats, and are able to adjust to seasonal variations in temperature by either thickening up or shedding their hair. The ciliæ in the nostrils serve as filters of the air we breathe; the eye-lashes and eye-brows aid in keeping dust particles from entering the eyes. The fine, downy hair which covers the human body is a relic of the hairy coating which our forbears possessed in abundance, and which is still to be seen on the bodies of savages and aborigines.

Every one is familiar with the phenomenon of the "hair standing on end." Physiologically, this is made possible by the fact that several very small skin muscles are attached to each hair follicle; these muscles, reacting spontaneously whenever the body is chilled, or occasionally when we are overcome with a sudden fear, cause the skin to be furrowed into "goose flesh," and the hairs to stand more or less erect. In the dog and cat, we are familiar with this phenomenon of

"bristling" in the anger attitude. Undoubtedly in the primitive life of the human organism the skin muscles played a rôle of far greater importance than they do in civilized life. To-day, while goose flesh enables us to retain our bodily heat better in an emergency, and warns us that we have been in the cold bath long enough, it has lost much of its physiological and psychological significance.

The oil glands. Another very important type of miniature organ, lying also in the dermis, is the *sebaceous gland*, or *oil gland*. Most of these tiny glands pour their secretions of oil through ducts that open into the side of the hair follicle, although a few of them open directly upon the surface of the epidermis. These glands are found throughout the entire extent of the skin, excepting on the palms and soles, and are particularly large and numerous on the face. Functionally, the oil glands keep the epidermis moist and flexible, and render it less permeable to water. Feathered creatures may often be observed before a storm "water-proofing" their plumage by darting their bills here and there among the feathers and injecting droplets of oil into and among them. Human beings are "water-proofed" automatically by the action of the sebaceous glands. The oil secreted by these glands into the hair follicles serves also to keep the hair smooth, soft, and glossy: this is Nature's own hair oil, and it cannot be improved upon. Friction between contiguous or opposing surfaces is reduced to a minimum by the secretions from the sebaceous glands.

The nails. Another specialized form of epidermis is the nail. Like the hair, the nail is rooted in a fold of the dermis. Unlike the hair, however, the nail grows not only from its root in the nail-fold, but along its bed of dermis, only the front end of the nail being unattached to the dermis cells. The nail grows from its root, pushing itself continually forward as the new cells are formed. It will prove an interest-

ing experiment to make a visible scar upon a nail near the half-moon and observe the progress it makes from week to week toward the tip of the finger. It will be found that in a period of about sixteen weeks the nail will have moved forward approximately its entire length. The nail contains no blood-vessels, its apparent pinkness being due to the proximity of the blood-vessels in the nail-bed beneath, which is true skin and hence vascular. The natural transparency of the nail shows up very plainly the color of the blood just beneath, much as the lips do.

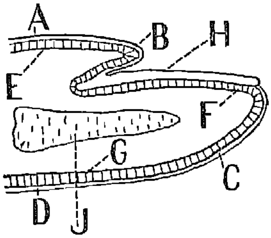

FIG. 8. A NAIL

Showing its relationship to the cuticle and dermis. *A, B, C, D*, epidermis; *E, F, G*, dermis; *H*, nail; *J*, bone.

Functionally, the nails serve to protect the ends of fingers and toes, to stiffen the extremities, and to aid in picking up small objects, such as pins, twine, etc. In the lower animals we find corresponding anatomical structures in scales, claws, beaks, horns, hoofs, and other organs of protection, locomotion, and defense.

The nail-forming property of the skin may be seen in a modified form in the horny calluses which are thrown up on the soles of the feet, on the sides of the toes, and in the palms of the hands, where the chief wear comes.

2. *The hygiene of the skin and its derivatives*

The complexion. A woman's complexion is at once an index of her health and of her good sense. Of the first of these, we need say little; it is so obvious that the skin is an outward evidence of the internal condition of the organism, which he who runs may read. Of the second we need to say a bit more. Nature has given to us nothing more beautiful than our skin. It is an object of beauty in which Nature

herself seems to take great pride, for she sees to it that it is renewed daily from her storehouse of wealth. Yet there are multitudes of women who presume, by cosmetics and powders, either to improve upon the natural flush of health as revealed in the complexion, or to attempt by frequent recourse to them to conceal a poor condition of inner health, or else to sully with them the natural beauty of mellowing age. Saddest and most foolish of all is it for a girl or young woman to resort to the crude construction of an artificial complexion which can never even approximate the fairness and freshness of youth, and which cannot but make her an object of silent ridicule to right-minded and worth-while people of all ages.

This of course does not mean that one's complexion cannot be improved by legitimate means. Skin and complexion difficulties may be classified under two heads: internal and external. Under the former caption come all those troubles due to digestive and assimilative disturbances, to accumulated waste products of metabolism, to toxins and such other irritants as tend to affect the body adversely. The first rule to observe for the improvement of one's complexion is to maintain the personal health at the highest possible level, being especially solicitous regarding the processes involved in alimentation. Nothing can make more for a clear complexion and an attractive skin than a sensible diet and a good digestion.

Among the external factors which have an injurious effect upon the texture and smoothness of the skin may be mentioned continuous or frequent exposure to sun and wind; heavy or binding clothing; insufficient and infrequent cleansing; too strong soaps; excessive use of hot water, etc. Any or all of these and other agencies may cause roughening, cracking, chapping, inflammation, black heads, etc. The second rule to observe for the improvement of one's complexion is, therefore, to keep the skin well cleaned, pro-

tected, and ventilated. Those young women who follow both this and the preceding rule will find it unnecessary to resort to creams, powders, and rouge: their skin and their complexion will be naturally beautiful and attractive. The fact remains, of course, that for unnaturally dry or for irritated and chapped skins, creams and other toilet preparations and lotions are the proper means to reduce irritation and to keep the skin sweet in warm weather.

Much has been written about the virtue of various kinds of so-called toilet soaps. Popularized by persistent advertising, there are on the market large numbers of soaps claimed to be indispensable for the toilet. There can be no doubt of the need of soap for cleansing the skin. The alkali — which all soap contains, along with fat — renders the skin much more readily miscible to the water. Any reasonably pure soap must contain alkali, and is about as good as any other, regardless of whether or not it contains perfume, and whether or not it is 'medicated.'

Warm and cold bathing. The continuous action of the perspiratory glands, which are second only to the kidneys in the amount of impurities which they excrete, keeps the surface of the skin constantly polluted with salts and other chemical wastes. These, along with the worn-out epithelial cells continually sloughing off, and the dirt and dust that accumulate on the skin in greater or lesser quantity during the day, require to be removed frequently by bathing. For this purpose, the warm bath is to be recommended. Cold bathing fills a distinct need of the organism, as we shall see, but it is not very efficacious for cleansing the skin of dirt and grime and the accumulated residue of peripheral excretion.

In addition to being an agent of cleanliness, the warm bath has ordinarily a soothing effect on the nervous system, and persons whose experiences and duties during the day have been unusually trying to the nerves are likely to find

that about the most hygienic thing they can do is to take a moderately warm bath just before retiring. The warm bath is also a grateful lotion after strenuous physical expenditure which leaves the muscles tired and sore, and perhaps even aching. Once or at most twice a week should be sufficient for warm bathing, unless one is engaged in a form of work that necessitates daily ablution. Taken too often, this type of bath is likely to have too relaxing an effect upon the skin muscles and to reduce too much the natural oiliness of the skin.

By far the best type of bath for daily purposes is the cold bath. Unlike the warm, cold bathing acts as a stimulant not only to the muscles of the skin blood vessels, but to the whole peripheral nervous system as well. By its low temperature the cold water drives the blood from the cutaneous vessels inward to the internal organs, lessening the pulse beat somewhat and lowering slightly the bodily temperature. The splashing of cold water upon the surface of the body is the best means available for training the muscles in the cutaneous blood-vessels to react promptly and infallibly to sudden changes in temperature. Persons whose skins have been so trained are far less likely to take cold from sudden exposure or from the ordinary diurnal and seasonal changes of temperature than are those whose blood vessels contract more slowly by virtue of their lack of training in such situations. Reacting thus more tardily, the blood in them may be chilled before it can be withdrawn inward, and then if there are germs of cold lurking about, the mischief is done.

Shower baths are obviously the finest indoor means of training the skin to vigorous reaction, as is swimming in lake or river the best outdoor means. Where neither of these is available or practicable, however, cold tub baths will be as effective, excepting of course that they lack the thrill and excitement of the actual splashing of the water. Many

people living in rural regions improvise shower baths and enjoy all their benefits by perforating a large water pail with small, strainer-like holes and elevating it over the tub. Where this is impractical, it will at least be possible to splash the cold water upon the chest and pour it over the body with a sponge.

The cold bath not only tones up the muscles of the cutaneous vessels, but it has also a psychological effect for most people that the warm bath does not have. It tends to make the person indulging in it wide-awake, alert, and aggressive, and inspires within him a feeling of power, confidence, and well-being. Because of its stimulating effect, the cold bath is best taken upon rising in the morning, or at some other time during the day than at bed-time.

Not all people can take cold baths. For the aged person not accustomed to them, for the physically unwell or delicate, and for the person who is afflicted with actual pain and crampings while in the bath, it would be absurd to recommend them. For most normally healthy people, however, cold bathing is to be very strongly recommended, if only as a safeguard against the taking of cold. Those who find it annoyingly unpleasant at first can usually habituate themselves to it by starting in with warm or tepid water, and little by little during succeeding days lowering the temperature until it is actually cold. It goes without saying, of course, that no one should use cold water for bathing that is unpleasantly cold, or that cannot be warmed up to readily. Brisk rubbing of the body after emergence from the bath will bring the blood quickly back to the surface, with its spreading glow of warmth and pleasantness.

Clothing. The clothing of human beings, in order to be as nearly as practicable like that of the animals in the natural state, needs to be possessed of three important qualities: lightness, porosity of texture, and looseness of fit. Except

for extremely cold weather in north temperate and frigid zones, cotton woven loosely is the most satisfactory and hygienic material for undergarments. It does not absorb and retain the excretory products of the perspiratory glands, as wool does; it is much less irritating to the skin than wool; it does not shrink or lose its shape when washed; it is cool; it is cheap. Healthy persons can wear cotton undergarments the whole year round without danger, provided of course their skins are well-trained and vigorous. Linens and silks, properly woven in loose mesh, are equally good for undergarments from a hygienic point of view; but they are considerably more expensive than cotton, and are no more satisfactory. For outer garments, woolen goods have been found ever since the days of 'homespun' to render the best service, especially during the colder seasons. Linens, cottons, silks, and cloths derived from their manufacture afford excellent materials for outer garments in tropical climates, and for wear during the warmer season in temperate zones.

While undoubtedly more people err on the side of wearing too much rather than too little clothing, it should be pointed out that too scanty clothing during cool and cold weather is to be guarded against carefully. An extra garment should be put on whenever the seasonal variations produce in the body a persistent feeling of chilliness. Going without overcoats and wearing the lightest clothing in extreme weather as an evidence of one's vigorous constitution, or as a matter of 'stylishness,' cannot be defended on the grounds of common sense, and the excessive loss of heat which the body continually incurs puts an added strain upon the organism in maintaining the body temperature. To wear a silk undergarment and a silk dress and light cape in our northern States in January is as absurd as to wear furs about the neck in July; both types of absurdity are commonly met with, however.

Besides being light and porous in order better to ventilate the skin, clothing needs also to be moderately loose-fitting. No garment which continually obtrudes itself into consciousness because it binds or cramps one should be tolerated. Particularly important is it to avoid tightness about the throat, chest, waist, abdomen, and the feet. To this end, special attention needs to be given to the selection and adjustment of collars, waists, garters, corsets, skirts, belts, and shoes. The well-dressed person is the person who looks neither 'sloppy' nor 'tight-laced,' but who is so clothed as to be, in the first place, absolutely comfortable, and in the next place unhampered in moving about and in performing the ordinary routine of the daily work.

Care of the hair. Everybody admires a fine head of hair, and if proper pains are taken in caring for the scalp there is no good reason why nearly all of us cannot be possessed of hair in abundance. True, those individuals inheriting a tendency to baldness in the form of a poorly nourished scalp will need to put forth more determined and strenuous efforts to preserve their hair than will be required of those blest with a thick scalp that is well supplied with the life-giving blood vessels; the fact remains, however, that for most people baldness is as needless as it is undesired.

There appear to be two conditions favorable to the loss of hair and the development of baldness; the first of these is persistent failure to keep the scalp and hair clean; and the second is a tardy or deficient circulation of blood in the scalp vessels. Dandruff, a condition due to the accumulation of loosened epithelial cells mixed with oil from the sebaceous glands, is the best evidence of an unclean scalp, and its presence in the hair is an eloquent and invariable forerunner of baldness. While it is true that the oil glands are considerably more active in some people than in others, and hence that dandruff forms more plentifully on some scalps

than on others, plain, ordinary brushing, with frequent shampooing, will keep any healthy scalp perfectly clean. Daily brushing of the hair for several minutes will not only remove most of the dandruff that has collected in it since the previous brushing, but will also lend lustre and beauty to it. The equestrian knows well that the sleekness and glossiness of his mount are due to the persistent regularity and vigor with which he wields brush and curry-comb upon his coat. Since, however, brushing alone will not cleanse the scalp, occasional shampooing of the hair becomes necessary.

A good quality of soap should be used for this purpose, and the lather rubbed well into the scalp with the ends of the fingers or with a moderately stiff brush. Commercial brands of liquid shampoo have no points of superiority over pure soap. After cleansing, the soap should be washed completely from scalp and hair with warm water, and the whole process be concluded with a douching of cold water. Thorough drying is essential. Shampooing should be done as often as the hair appears to need it; some people require it weekly, or even oftener; others maintain their scalps in good condition by washing them not oftener than once a month. The nature of one's occupation and the activity of the sebaceous glands should be important factors in determining the frequency with which shampooing is to be recommended for a given individual. It is a fallacy to contend, as not a few persons do, that washing the hair induces excessive dryness of the scalp through the removal of too much oil. As a matter of fact, while the hair is obviously dry after shampooing, the cleansing process improves the circulation and stimulates the activity of the glands, so that in a short time the hair not only regains its oiliness but actually becomes somewhat more oily than before. Scalps which fail to react thus fairly promptly may be softened and the luster of the hair improved by the application of pure vaseline or olive

oil after the shampoo. Another absurd opinion sometimes maintained is that the vigorous rubbing accompanying the shampoo loosens the roots and tends to make the hair fall. Nothing could be further from the truth. Loose hairs, of course, are removed in this way, as well as by combing and brushing. There is no better way to stimulate the hair roots and restore a good head of hair after a temporary falling due to illness than to massage and shampoo the scalp.

The second predisposing cause of loss of hair and baldness is an insufficient circulation of blood in the scalp. This appears to be largely an hereditary condition. In general, scalps that are reasonably thick and can be moved rather freely over the cranial bones are thought to be well supplied with blood vessels, and the growth of hair upon them is likely to be luxuriant. Good nutrition is, in other words, a prime condition of normal growth of hair cells, as of all other types of cell in the body. Scalps which, on the other hand, are thin and cling tightly to the skull bones are less apt to be well supplied with the life-giving blood vessels, and hence are more predisposed to thin hair and baldness. Preservation of the hair on such a scalp is more difficult, and requires greater effort than is the case with the thicker scalp; it is not an impossible task, however, when diligently followed up. For this sort of scalp, in addition to the daily vigorous brushing and frequent shampooing — both of which processes are excellent stimulants to the circulation in the scalp — a few minutes of thorough massaging with the finger-tips every morning and night is an excellent means of improving the circulation and so the nutrition of the scalp. Continued persistently over a period of years, this practice, supplemented by the ordinary brushing and cleansing, will yield most gratifying results in the quality and thickness of the hair. If persons whose scalps are thin and poorly nourished would resort in time to these simple preventive measures,

and would throw away their hair tonics and restorers, they would not only save money but save hair!

Care of the nails. Nothing in the personal toilet is more unsightly than dirty or poorly kept nails. As much care should be given to these as to any other portion of the skin. It is important in the interest of keeping possibly infectious matter from the blood, as well as of keeping the hands beautiful, that the cuticle overhanging the root of the nail be pressed lightly but persistently back at least once a week; otherwise the nail, as it moves forward in growth, will drag the cuticle with it, and in a short time this will become torn, and disagreeable 'hangnails' will be formed. Blood poisoning, lock-jaw, and other less serious infections have often been caused by the entrance of microbes into the blood through the doorway afforded by a hangnail.

Trimming the nails carefully is another index of a person's character. Overgrown, uneven, torn, bitten, and dirty nails reveal more of one's personality than he is likely to realize. The nails should be filed, or else trimmed, preferably with curved scissors, along the rim of the finger-tips. Some people make a sort of fetish of trimming their nails to a point over the center of the finger-tip, like the claws of animals. Well-groomed nails are, however, curved conformably along the finger-tips, as Nature intended and designed them. The toe-nails should be trimmed straight across, as a means of preventing the painful in-growing nails which often result from curved trimming in these days when unnaturally tight or pointed shoes are too commonly worn.

Teaching points in this chapter. Not all of the material given in this chapter can or should be included in the teaching of the skin and its derivatives to boys and girls. In general, as we have seen in a previous lesson (see Chapter II), the minimum of anatomy and physiology and the maximum of hygiene should be observed in planning health

lessons for children. There are, however, certain simple facts of structure and function which can be profitably presented in every grade. The 'teaching sense' of the teacher must be largely left to determine just what structural basis the children are to be given on which to build the superstructure of hygiene.

The following topics are suggested as embodying the important things children should be taught about the structure and care of the skin and its derivatives. Some of them can be taught successfully, and with good results in the personal hygiene of the pupils, in the first grade; others cannot be handled well until the sixth. With all of them the young teacher should feel herself sufficiently familiar to judge the age or grade where they can be most economically and advantageously introduced. It goes without saying of course that the elementary presentation of a fact in a primary grade can and should be repeated and elaborated in the ensuing intermediate and upper grades: there is no more certain and infallible road to learning than the road called "Repetition," assuming of course that new settings and new bypaths are introduced anon along the road to render it always attractive and always rewarding of the efforts put forth in traversing it.

TEACHING POINTS IN THE CHAPTER

A. Structure and Function

1. Nature of the epidermis.
2. Skin color and the pigment cells.
3. Sensory end-organs of the dermis.
4. How the body maintains its temperature.
5. Influence of weather and climatic conditions on the body temperature.
6. The hair follicle and its lubricating mechanism.
7. The nail-fold.

B. Hygiene

1. The complexion: how marred? how improved? Fads and fakes.

2. Physiological and psychological effects of warm bathing.
3. Physiological and psychological effects of cold bathing.
4. Relationship of a pampered skin to susceptibility to colds.
5. Woolens for clothing material.
6. Cottons, linens, and silks for clothing purposes.
7. A 'well-dressed' person in the hygienic sense.
8. Cleanliness and neatness of the hair.
9. The hair, the scalp, and baldness.
10. Care of the nails.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Make a study of the geographic distribution of the five racial colors, and attempt to account climatically for the variations.
2. Draw a large-scale sketch of the epidermis and the dermis, including the cellular structure; the pigmented cells; the papillæ; the hair follicles; the skin muscles; the sebaceous glands; the perspiratory glands; blood vessels and nerves. Use colored inks or crayons as far as possible in order to make the several entries plain. Prepare an explanatory key.
3. Collect from the local newspapers and home magazines as many advertisements as you can find having to do with "complexion creams," "blood purifiers," "skin beautifiers," etc. Write a critical estimate of their probable values, in the light of the discussion of this chapter.
4. Write a page-theme on the subject: "How to avoid colds during the winter months."
5. Determine upon some hygienic habit suggested by the lesson which you feel you would like to form for yourself (e.g., cold bathing, loose clothing, well-manicured nails, etc.). Practice the habit conscientiously and diligently for the next three months, with a view of preparing a paper on your experience and impressions at the end of that time.

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2. Hutchinson, W. *A Handbook of Health*, chaps. 15 and 16.
3. Pyle, W. L. *A Manual of Personal Hygiene*, section 2.
4. Williams, J. F. *Healthful Living*, pp. 21–33.
5. Williams, J. F. *Personal Hygiene Applied*, pp. 279–301.

CHAPTER V

THE MUSCULAR SYSTEM

1. *Structural approach*

The importance of muscles. Passing from the skin inward through several layers of sub-cutaneous fatty cells, we come next to the muscles of the organism. These comprise about forty per cent of the total weight of the body of the adult, and constitute its main bulk. It may be stated that the primary function of muscles is to make movement possible. This term 'movement' must, however, be extended to include not only gross changes in position of the limbs and appendages of the body, as manifest in walking, playing ball, climbing, etc., but also all those finer automatic activities going on within a living body which differentiate it at once from a dead body: all animation is muscular at its base; all inanimation is the failure or absence of muscular response. Among the physiological processes, therefore, directly dependent upon the action of muscles for their performance may be mentioned the preparation, digestion, and assimilation of food; the excretion of wastes; the respiration; the circulation of the blood and lymph; and even, to a considerable extent, the activity of glands and the repair of cells. External and visible movement is but a single phase of a very complex property of the organism. Voluntary, involuntary, automatic, and reflex actions are all equally important types of muscular movements, as we shall see in the ensuing paragraphs.

Voluntary muscles. The most obvious type of muscle is the voluntary one. When we choose, we can walk, run, kick, sit, lie, crawl, throw, push, pull, squeeze, and perform

a host of other purposed acts, with the muscles and bones of our skeleton. Muscles whose control over bones is thus immediate and voluntary are known as skeletal muscles, since one or both ends of them is always found in attachment with a bone. Altogether, there are some 500 skeletal muscles in the body. Most cuts of lean meat bought at the market are taken from the flanks, shoulders or loins of animals, and constitute voluntary muscle.

Structurally, a voluntary muscle is unique, and is readily distinguishable from an involuntary one. Its make-up can be best understood by calling to mind the appearance of beef that has been boiled for several hours (e.g., pot roast). The boiling has so dissolved out the connective tissue binding the elements of the cells together that the fibers are quite readily detached from one another. An attempt to cut a piece of boiled beef cross-wise of the fibers results in shredding them. It is these tiny fibers which constitute the unit or cell of the muscular system. These fiber-like cells are not much more than one five-hundredth part of an inch in diameter, and their length is not ordinarily in excess of two or three inches. Under the microscope, they are seen to be crossed with alternating dark and light bands or stripes, and for this reason voluntary muscles are often spoken of as *striated*, or *striped* muscles. Figure 9 shows a sketch of two striated muscles magnified sufficiently to reveal the stripes, and showing also the arteries which supply the muscles with the nutrition which they convert into energy during exercise. Figure 9 gives us some basis for constructing a mental picture of a complete muscle, like the biceps in the forearm, for example. It would appear like a mosaic of hundreds of tiny, banded fibers,

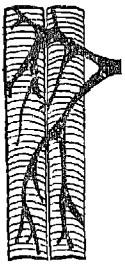

FIG. 9. PORTION OF TWO STRIATED MUSCLE FIBERS
Considerably magnified.

joined side to side and end to end into small bundles, and these in turn into larger bundles by means of connective tissue, and the whole mass enclosed in a very thin, sleek, retaining sheath, called the *sarcolemma.* It is interesting to note that, while the muscle fibers are copiously supplied with blood vessels, these do not in any case enter the fibers themselves, but are found only in the connective tissue that runs between and among the fiber-cells. Capillaries in abundance penetrate to the most remote part of this tissue, and supply each of the thousands of fibers constituting the muscle with the energizing food-elements needed for its daily round of work.

Tendons. If you spread open your hand, palm down, and move your fingers alternately backward and forward you will observe the action of four whipcord-like tendons near the surface of the back of the hand. You will be unable to observe the movements of the opposing tendons in the palm of the hand, since they are buried more deeply in the subcutaneous layers, but you can see and feel those on the palm-side of the wrist. If one could dissect out one of these tendons, he would discover that the lower or anterior end of it is attached to the finger bones (phalanges) by means of strong ligaments, and that the upper or posterior end seems to branch directly out of the muscles in the forearm. Under the microscope, he would find that the innumerable threads of connective tissue binding the muscle fibers into bundles are drawn finally together at the lower end of the muscle, and form the cord or tendon which runs down to the bones of the finger. Tendons are white, inelastic, and very strong, one as thick through as an ordinary pencil being sufficiently strong to sustain a weight two or three times as great as that of the body. You have no doubt come across these very tough cords in cuts of meat, and have marvelled at the resistance which they offered to attempts to break or sever them.

The function of tendons is interesting in the extreme. The real, potential strength of our fingers in grasping lies not in the fingers themselves, but in the muscles of the forearm. If a gymnast can register a grip of 75 kilograms on the dynamometer, the source of the energy expended is to be found in the stocky part of his arm, a good foot away from his fingers. Nature very kindly and considerately refrains from cumbering his fingers with the enormous muscle mass requisite for stiff finger-flexing by storing it away quite unobtrusively in the forearm. In this way she permits one to have small, deft fingers, able to perform a great variety of acts of skill, and at the same time capable of exerting a force out of all proportion to their immediate and direct muscular supply. Fancy a typist, or a seamstress, or yet a violinist cumbered with fingers the source of whose strength lay in muscles contained within them!

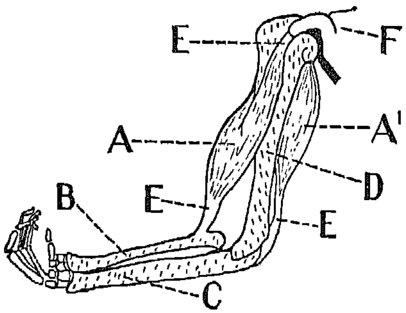

Fig. 10. Muscle, Tendon, and Bone

Showing the attachment of tendon to bone. *A*, biceps; *A'*, triceps; *B*, radius; *C*, ulna; *D*, humerus; *E*, tendon; *F*, shoulder girdle.

Tendons are then levers that connect skeletal muscles with bones. They are found not only between the forearm muscles and the phalanges of the fingers, but also between the upper-arm muscles (biceps and triceps) and the bones of the forearm; between the calf muscles and the foot bones; between the upper leg muscles and the bones of the lower leg (tibia and fibula), and may be readily felt in all these locations. Tendons are also found connecting muscles with bones in the neck, shoulders,

back, abdomen, and elsewhere, and may be easily located in most cases.

A study of Figure 10 will make plain the physiological features of the tendons in the upper arm connecting the biceps with the radius. At points where contraction of the muscle would tend to pull the tendon outward from its bed along the bone, a band of ligament is introduced to bind it securely down. Such a weak point would occur at hinge joints especially, and hence ligaments are found tying tendons down in the fingers and toes, larger ones at the wrists and ankles, and larger ones still at the elbows and knees, and in the back and loins.

Antagonistic muscular action. From what we have just been saying about the structure and physiology of the tendons, it should be evident that one set of muscles bends the fingers, hands, arms, legs, feet, toes, etc., and that another set extends them. Holding your hand thumb-up, slowly close the fingers and squeeze them tightly against the palm, feeling at the same time with the fingers of the other hand, the contraction of the front forearm muscles. Now open the fingers and straighten them as far back as you can, feeling the thickening and hardening of the muscles on the back of the forearm. Perform the same experiment by bending the forearm forward and backward, and feeling the action of the muscles in the upper arm. Repeat for the toes, feet, and lower legs, and try to locate the source of muscle supply for each.

Muscles which thus are designed to move the same bone or group of bones in opposite directions are said to be *antagonistic muscles.* They are not actually antagonistic, of course, for if each opposed the movement of the other we should be practically helpless. They are, however, antagonistic to the extent that when one works, the other rests, and *vice versa.* That one of a pair of antagonistic muscles that

bends the bone or bones is called the *flexor;* that one of the pair that returns the bone to its customary position is called the *extensor*. Thus, the biceps is a flexor; the triceps is an extensor: the biceps and the triceps are antagonists.

Locate other antagonistic muscles, and find the names of some of the more important ones.

Involuntary muscles. We have just seen that voluntary muscles are more or less completely under the control of and at the command of the will. There are, however, innumerable other physiological processes taking place in the organism which, if the will were to be consulted to guide and regulate them, would not only be seriously impaired, but would so tax the higher nerve centers in the cortex that life would of necessity be reduced to the lowest mechanical level. The muscles concerned with these inner physiological processes are never, or only very incompletely, at the command of the will, and are hence termed *involuntary muscles*. These are found in the walls of the internal organs: the food-tube comprising the gullet, stomach, and intestines; the heart and blood vessels; etc. Over the activity of these muscles the will has little, and in most cases no, controlling influence.

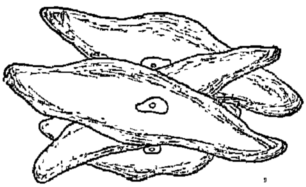

FIG. 11. SEVERAL SPINDLE FIBERS (*involuntary*)

Structurally, while it is true that some of them resemble the striated tissues, involuntary muscles are composed of unstriated fibers, which are much shorter than voluntary fibers, and are somewhat spindle-shaped; these are laced together and fastened by fine strands of connective tissue. Figure 11 presents a sketch of several of these spindle-fibers, with their nuclei, highly magnified. The actual length of unstriated fibers is somewhere in the

neighborhood of one four-hundredth part of an inch. Like the voluntary muscle fibers, the spindle-cells of involuntary muscles derive their nutrition from the capillaries lying in abundance enmeshed within the connective tissue network which joins them together into the complete muscle.

Automatic action. An interesting illustration of automatic action is to be found in the movements of the respiratory muscles, which comprise chiefly the diaphragm and the inter-costal muscles. These muscles are controlled by a nerve center in the sub-cortical area (the *medulla oblongata*), and are hence properly thought of as involuntary, although they may be for a few seconds brought under the control of the cortical centers, and so made obedient to the will. Experiments have indicated that the automatic regulation of the rate and depth of respiration by the medulla nerve center is conditioned upon the presence or absence of excessive carbon dioxide in the blood, this gas acting as a stimulant to the center. Thus, when metabolism is greatest, as during physical exercise, more carbon dioxide is thrown off by the cells, the relative amount in the blood is raised, and the respiratory center forthwith and automatically increases the innervation of the respiratory muscles in order promptly to remove this excess and restore the proper balance of oxygen. The action of the heart must be regulated correspondingly, of course, in order that the non-aerated blood may be brought to the lungs in greater volume. Other automatic centers originating in the medulla control the heart; these are much less subservient to cortical interference than is the respiratory center.

Still another illustration of automatic muscular action is presented by the process of digestion and assimilation of food. Chewing automatically causes discharge of saliva from the salivary glands; the arrival of food in the stomach automatically stimulates the gastric glands to secrete their

digestive juice, and also sets into automatic activity the muscles of the stomach wall, so that the food is thoroughly mixed with the digestive elements and reduced to chyme; when the process has gone on for the requisite number of hours, the sphincter muscles in the pylorus relax automatically and periodically, discharging the chyme little by little into the small intestine; the presence of food in the small intestine automatically stimulates the release of bile, pancreatic juice, and the intestinal fluids, and causes innervation of the muscles in the intestinal wall, thus insuring continued mixing and reducing of the food elements. Absorption of nutritious particles of food at the villi; discharge of unreduced and non-nutritive matter into the large intestine; further absorption there; and the initial steps toward excretion, complete the automatic progress of food through the alimentary canal. Over none of these processes does the will exercise any controlling influence.

Reflex action. Strictly speaking, an automatic act is one whose stimulus is internal to the organism. Thus, the increase in activity of the respiratory and cardiac muscles during exercise is stimulated by a modification of the chemistry of the blood, due to increase in its CO_2 content; similarly, the numerous successive steps in the digestive process are conditioned upon the stimulus offered by the presence of food at this point or at that. There is another form of muscular activity which is stimulated by some agency external to the organism itself, and to such response we apply the term 'reflex action.' Essentially, reflex action is involuntary, although it may be accomplished by voluntary muscles. Thus, I may will to remove my hand from the top of my desk, or I may involuntarily remove it from the top of a hot stove upon which I have inadvertently placed it. In either case, precisely the same fundamental muscles are employed, although the reaction may be more violent and pervasive in

the latter than in the former case. Other examples of reflex action may be seen in the eye-wink, which occurs quite involuntarily upon the sudden irruption of a near object within the field of vision; in the knee-jerk, which occurs when a light blow is struck on the patella; in the drawing-up of the foot when the sole is tickled; in the cough or sneeze induced involuntarily by the impinging of some irritating particle upon the naso-pharyngeal membrane; in the sudden turning aside of the head in the face of an imminent blow, etc. Typical forms of reflex action may also be manifested by any voluntary muscle or group of voluntary muscles attached to the skeletal system whenever a strong, unexpected, or painful stimulus is offered. There may even occur a violent reflex discharge of energy in all the muscles of the body simultaneously, as, for example, when one is startled by a loud explosion, or a sudden shout, or upon unexpectedly encountering a person in close proximity.

The essential condition of muscular contraction. When a skeletal muscle contracts its length is diminished and the diameter of its body is increased, without there being produced any variation in its gross bulk or mass. The individual fibers making up the muscle merely shorten and thicken, thus modifying the shape but not the volume of the muscle. A good example of this phenomenon of muscular action may be seen in the behavior of the forearm as the biceps is flexed and extended. Flexion brings the point of insertion (shoulder-end) of the muscle nearer to its point of attachment in the forearm; extension of the arm separates more widely these two points. All muscular contraction consists essentially in this shortening and thickening process, alternating with a complementary lengthening and thinning-down process between the stimuli.

But of what do the stimuli that set off muscular contraction consist, and what is their nature? If we remove the

gastrocnemius muscle from the leg of a frog and connect its tendon with a weighted writing-lever attached to a slowly revolving kymograph drum, and then insert within it the wires from a battery, we shall find that the muscle will contract and relax alternately and that its movements will be traced plainly upon the drum. Figure 12 presents a diagram of this interesting experiment. From this demonstration it appears that the essential condition of muscular contraction is stimulation; if we remove the wires from the muscle its contractions will immediately cease.

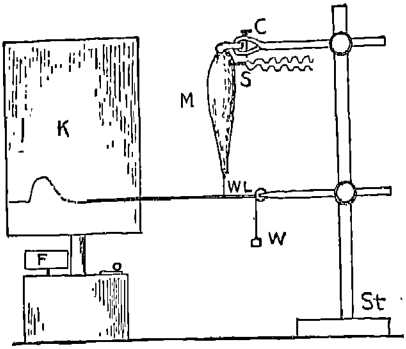

FIG. 12. A METHOD USED TO REGISTER MUSCULAR CONTRACTION

St, stand for holding of clamp *C* and writing lever. *WL*, the muscle *M* is attached to the lever by means of a small hook and string. The lever is counterpoised by weight *W*. The stimulation is effected through the electrodes *S*. The speed of the kymograph *K* may be varied by fan *F*. (From *An Elementary Manual of Physiology*, by Russell Burton-Opitz. Courtesy of W. B. Saunders Company, publishers.)

Within the living organism, human or otherwise, the stimulation which was furnished in the experiment with the gastrocnemius by a mild electric current is supplied by a nerve current. As Figure 13 indicates, each separate fiber making up a muscle is supplied with at least one branch from a nerve fiber, to the presence of which it owes its

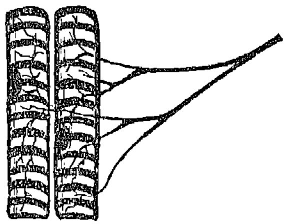

FIG. 13. SCHEMATIC DIAGRAM TO SHOW NERVE SUPPLY TO MUSCLE FIBERS

ability to contract. Without the nerve filaments running through it, a muscle would be impotent. Let a break or lesion occur at any point along the conducting path, or let any injury to the motor center occur and the particular muscle or muscle group depending upon it will become forthwith paralyzed, even though there be no injury to the muscle itself. You doubtless know one or more persons afflicted with paralyzed arms or legs, or who are helpless in other local parts, yet whose muscles anatomically are unimpaired: the trouble is to be sought somewhere along the nervous pathway between the motor center and the muscle end-plate.

We may roughly liken the muscle-contracting mechanism to an electric door-bell apparatus. The buzzer itself, which is the moving part, remains lifeless and inert unless and until the discharge of current into it from along the wire throws it into activity. Let the wire be broken, or a connection be loosened, and no ringing can take place. The chief point of inappropriateness of this figure is to be found in the source of energy whence the door-bell derives its power and that whence the muscle derives its power. In the former mechanism, the energy is stored in the battery or cell, which is physically totally disconnected from the bell, while in the latter mechanism the energy is stored in the muscle itself. Reception of a stimulating influence along a nervous pathway in the muscle fibers causes them to discharge a portion of their stored-up energy in the form of a contraction. A series of such stimuli from the motor nerves leads obviously to a succession of contractions, as in a working muscle.

The essential condition of muscular contraction is then stimulation by means of a motor nerve impulse. In the case of most of the skeletal muscles which are concerned with locomotion it is now known that the innervating nerves travel in every case from a region in the anterior convolutions of the cerebral hemispheres, called the *motor area*. In

the case of the unstriated muscles in the involuntary system, the controlling motor centers are to be found on the lower levels of the central nervous system, in the autonomic system, and sometimes in the immediate vicinity of the organ itself.

The marvelous integration of muscles and nerves. There is nothing more marvelous in the body, save perhaps the marvel of life itself, than the coördination and coöperation which exist between the nervous system and the musculature. Let us suppose the case of a player who is in the act of catching a ball. His eyes inform him of the position of the ball, and as it approaches his mitt he is able to judge its curve, speed, and position so accurately that his outstretched hands and arms and his finely balanced body seem almost machine-like in the precision of their movements. And yet it is but the trained interplay of nerves and muscles that make possible all this efficiency of action.

Let us investigate a bit. The eye-movements of the player are muscle movements, but his oculo-motors could not move unless they were innervated by nerves, and they could not guide his eyes along the course of the ball thus accurately unless they were innervated with the greatest perfection. His hand and arm movements are muscle movements, too, and how marvelous the innervation of those muscles! His breathing is half in suspense; and how delicate the nervous control of diaphragm, intercostals, and abdominals. His circulation is speeded up by the strenuousness of the game, and yet how perfectly under control are his movements. Every cell of his body is consuming energy, but the life stream is coursing in full vessels with more oxygen and more fuel for the fray, its speed of flow regulated delicately by the pump-muscle. And all of these finely coördinated movements of the player's body — some of them external and visible, more of them internal and in-

visible — comprising hundreds of skeletal muscles, thousands of unstriated muscles, and millions of nerve fibers, are so perfectly integrated and unified that there is no waste of energy, no clumsiness of act, and no inadvertence of attention: the entire dynamic force of the player's organism is fixated utterly without friction upon catching the speeding ball. Marvelous indeed this neuro-muscular mechanism of ours!

Some interesting types of muscles and muscular action. We have already referred to the antagonistic action of certain skeletal muscles. In this section we are to consider some other interesting types of muscles and of muscular behavior. One of the most interesting muscles is the *gullet*, or *œsophagus*. This is a nine-inch tube, made up of a series of cartilaginous rings connecting the back of the mouth with the stomach. A series of circular muscles, connected by longitudinal muscles, makes up the muscular coat of the gullet. The moment a morsel of food has been rolled into a ball (bolus) and forced backward into the pharynx by the action of the tongue squeezing against the hard palate, the pharynx muscles grasp it and push it downward into the first ring of the gullet. From that point the gullet acts as an involuntary muscle, the bolus being squeezed from ring to ring successively down its nine inches by peristaltic action. About five seconds are required for ordinary food, mixed with saliva, to make the passage through the œsophagus, although liquids require much less time. If we initiate the swallowing reflex oftener than once a second, it appears that the rather complex muscular adjustments of the pharynx and œsophagus cannot be properly made, and we become very soon conscious of a painful feeling of dilation along the

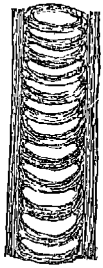

FIG. 14. THE ŒSOPHAGUS
Pen sketch to show its vertical and circular fibers.

gullet. Boys who "eat too fast" are occasionally afflicted with this inconvenience, as any of them can easily testify.

The muscle rings about the œsophagus may also be taken as a type of so-called *sphincter* muscles. A sphincter is defined as a circular muscle whose contraction reduces its diameter. Thus, when the bolus is pushed against the first sphincter of the œsophagus by the pharyngeal muscles this narrows down and pushes it on to the next sphincter, and so on until the stomach is reached. Other examples of sphincter muscles are afforded by the muscle about the mouth; those around the eyes; the iris, or colored portion of the eye which regulates the size of the pupillary opening; the muscles around the intestines; and elsewhere throughout the body.

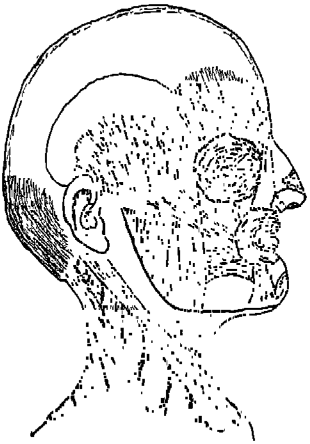

FIG. 15

Pen sketch to show the principal facial muscles, or "muscles of expression."

The *facial* muscles, or the *muscles of expression*, are those found in the vicinity of the mouth, cheeks, nose, and eyes. In addition to the sphincters already mentioned, these include several small muscles running from the mouth sphincter and connecting it with various parts of the face. One pair of these draws down the corners of the mouth, as in scowling; another pair draws the mouth back, as in smiling; others draw the corners and sides of the mouth upward, as in sneering. Still other facial muscles coöperate to produce grinning, smiling, and laughing; others dilate the nostrils and compress the nose, while others raise the eye-

brows, forehead, etc. All of the facial muscles are under voluntary control, although they may react spontaneously to register feeling and emotion.

Additional muscles of interest in the organism are the *diaphragm*, which separates the chest cavity and the abdominal cavity, and serves to increase the height of the former during respiration; the heart, which is essentially a four-chambered, *hollow* muscle, the contraction of which is known as *systole*, and the ensuing expansion of which is known as *diastole;* the *trapezius*, a large trapezoid-shaped muscle of the upper back, by which the head and shoulders are drawn back; the *gastrocnemius*, a large muscle in the calf of the leg, which is connected with the heel by the largest tendon in the body — the tendon of Achilles — and which enables one to stand on tip-toe; and the *sartorius*, or *tailor's muscle*, the longest in the body — about two feet — which passes transversely across the front of the upper leg from the outer side of the hip-bone to the inner side of the leg below the knee.

We have already made mention of a peculiar type of muscular action known as peristalsis. Peristaltic action consists of a wave of contraction and expansion passing along the entire length of a muscle wall. Besides the peristalsis observable in the œsophagus, this type of muscular activity takes place in all parts of the alimentary canal; thus, in the stomach the food is reduced to chyme by the peristaltic activity of the muscles in the stomach wall; it also occurs in the small intestine in the form of waves passing from above downward; and in the large intestine in the form of waves passing both downward and upward.

Fatigue and its cause. Every one knows that continuous use of any group of muscles results, sooner or later, depending upon the speed and severity of the exercise, in fatigue and, if the activity is carried to an extreme, even in complete

temporary paralysis. Thus, experiments with the ergograph indicate in a measurable way the onset and progress of fatigue in the muscles of the arm. You have experienced something of the phenomenon of fatigue of a muscle group on some occasion when you were obliged to write rapidly and continuously for several hours. After a time it became exceedingly difficult to push the pen at all, and you were constrained, notwithstanding the rapidly passing time, to pause anon for a moment to relax your fingers and wrist in the hope of speeding up the circulation of blood to your hand and arm. Think of some other circumstances in which you have undergone actual muscular fatigue.

Physiologically, fatigue represents merely an accumulation of waste products thrown off by the cells during the process of metabolism. As we know, activity of a muscle increases its rate of metabolism; this means that more katabolic processes are thrown off when a muscle is working than is the case when it is at rest. Under normal conditions, that is to say, when the activity of the muscle is not strenuous, as in leisurely writing, these metabolic wastes are removed promptly by the blood flowing through the muscle, and the broken-down cells are repaired by the nutritive materials and oxygen which it brings. But under stress of vigorous and sustained action, the muscle consumes so much and releases so much that the blood is unable to take care of the accumulating wastes, and it becomes slowly clogged with them. This freighting of the blood stream with waste katabolic products is the physiological explanation of muscular fatigue. Only rest, with or without sleep, depending upon the duration and violence of the activity, can restore the proper condition of the cells and blood. Mental fatigue is partly at least due to a similar accumulation of waste products in the blood vessels of the brain. What is merely local fatigue at first may, by reason of the admixture and

circulation of fatigue toxins, be spread to other parts of the organism and induce a condition of general fatigue and even exhaustion. Chemical analysis reveals the fact that these metabolic wastes are made up in large part of lactic acid, potassium phosphate, and carbon dioxide. Experimentation has shown also that when the blood of a fatigued animal is infused into the vessels of a fresh animal, the latter forthwith manifests all the symptoms of fatigue exhibited by the former.

2. *The hygiene of the musculature*

How do muscles grow strong? The more a mechanical contrivance like an automobile is used, the more quickly it gets worn out and falls to pieces. The more the muscles that help to make up the mechanism of the human body are used, the stronger and more serviceable they become. As we have already seen, a greater volume of blood is furnished a working muscle than a resting one; consequently, when a muscle is used a great deal an increased supply of nutritive substances is sent into it and its cells grow larger and multiply more rapidly. It is through exercising them, then, that muscles grow larger and stronger. You have only to contrast the puny, flabby, and undeveloped muscles of an invalid with those of a healthy, vigorous person to have a striking proof of this fact. In a somewhat less extreme form, the same thing may be demonstrated by comparing the muscles of persons leading a sedentary life with those of persons who lead a life filled with physical activity. Individuals of the former class may be stouter than those of the latter, but their stoutness is due rather to an excess of accumulated soft fatty tissue than to the sturdy development of firm muscle tissue. The muscles of individuals belonging to the latter classification are hard and rugged. There is a vast difference between the person who vegetates and the

person who exercises. Those who lead the sedentary life need, therefore, to be constantly on their guard against over-eating, and to seize every opportunity that offers of indulging in moderately stiff physical exertion in order to reduce to a minimum the amount of fat that is so easily accumulated, and raise to the maximum the potentiality of their muscular system.

It is obvious, of course, that youth is the proper time for developing the muscles. Not only do muscles trained by wise exercise in the early years retain their development longer, but there is good reason to believe that the development of muscles stimulates also the development of brain cells. Every one of us has large tracts of brain cells that are little more than embryonic which might receive normal stimulation and so grow beyond the rudimentary stage if we but took the time and pains to give them the opportunity through a wise system of physical culture. Besides, if we form the habit of indulging in athletics and physical exercise in our youth, we shall be much more likely to continue so to do during our years of maturity, and will be the better off because of it. Most adults who have never accustomed their bodies in youth to the demands of the active physical life are likely to find it irksome to so accustom themselves in middle life, as they will be constrained to do if they purpose to achieve a healthy and ripe old age.

New demands for physical exercise. A generation ago little was heard, outside of a few private institutions and fewer imported schools of physical culture, of education of the physical organism in connection with the public secondary and elementary schools. Boys and girls had their "chores" and their household duties to perform. Nearly everything required for comfort, whether food or clothing or shelter, was produced in the home or in the community, and in their manufacture and preparation the boys and girls had

prominent and important parts to perform. No wonder little was heard or thought about physical training. What better training of hand and muscle than that afforded by the daily rounds of chores and work at home before and after school and during the long vacations?

Nowadays, however, all this has changed. Except for the farm boy and girl, there are no longer chores to be done, and the home manufacture of commodities for home consumption no longer exists. Markets and furniture stores and clothing stores and millinery stores and department stores supply all the articles needed, and even deliver them at one's very door without extra charge! Going to market or to church or to school is no longer commonly a question of walking, or even of bicycling, but merely of hailing the passing trolley, or starting up the automobile. It almost seems as though all the agencies of civilization had conspired to deprive the eager muscles of boys and girls of this generation of all chance to grow sturdy and hard by healthy and vigorous exercise.

All this implies, of course, the necessity of some other agency than the home supplying the opportunities for physical exercise and development that were formerly afforded by it. The school comes logically and properly to be that agency, supplemented in most progressive communities by boys' clubs, girls' clubs, scouts and camp-fire organizations, church athletic teams, community centers, playground associations, etc. All these and other agencies professedly and unselfishly striving to promote the physical welfare of the boys and girls are deserving of the enthusiastic support and coöperation of every teacher, as well as of every good citizen of the community.

Excellent forms of exercise for children. As a general rule, it is safe to say that whatever kinds of games or exercises are most interesting and enjoyable to the player are the

best forms of exercise for him. Too much cannot be said of the psychological value of keen interest in what we are doing. Absence of real enjoyment and even enthusiasm is what causes so many of our gymnastic drills to be not only disliked, but even thoroughly despised by great numbers of children. This should not, of course, be interpreted as minimizing the value of prescribed gymnastics in their place as specific correctives for specific physical and muscular defects. There is no question, however, but that much if not most of the time devoted in many schools to setting-up exercises and drills could be much better expended by lively and interested participation of the children in games and sports. In the latter forms of activity, the recurrence of situations involving competition, self-rivalry, display, and applause raises the action above the mere humdrum of exercise and elevates it into the lofty and enchanting plane of play; the twain are as far apart as the east is from the west.

What, then, are some of the most desirable and interesting games and sports over which children can be counted upon to become enthusiastic? *Running games* can always be depended on because of the keen interest that always centers around the chase. Tag, prisoners' base, and duck-on-the-rock represent some of the favorite sports of children; they involve few rules, and can be engaged in by large numbers of children simultaneously. Among *group games*, volley ball, dodge ball, tug-of-war, and various forms of relays are excellent. *Primitive activities*, such as camping, swimming, camp construction, outdoor cooking, hunting, fishing, exploration, and other forms of sport promoted by the scout and camp-fire organizations, are ideal types of healthy exercise for holidays and week-ends. *Team games*, such as basket-ball, baseball, and football are to be recommended as excellent exercise for those athletically inclined, and as an

indispensable means of developing school and community spirit. Games of this sort are about the finest means we have of developing self-control, coöperation, presence of mind, self-abnegation, and other desirable social qualities in adolescents. Dancing, especially folk-dancing, if taught as a means of graceful and rhythmic expression and not as a series of mechanical movements more or less in time with blaring music, should be provided for every child as a means of developing poise, gracefulness of movement, and ease of bearing in public.

Dangers in extreme athletics. While it is unquestionably the case that most persons keep themselves constantly below their best achievable physical condition by reason of insufficient muscular development and exercise, it is also true that some who indulge too strenuously in the more arduous forms of athletics overtax their organisms and shorten their lives considerably.

The difficulty principally is that too many athletes develop themselves in a one-sided manner; that is to say, they develop certain muscles enormously in order to perform a specific type of exhibitional work, and neglect certain other more vital ones, such, for example, as the lungs and heart. Such inharmonious development of isolated muscles puts an additional nutritional strain upon the vital organs to maintain them. Other athletes, especially those who perform feats of muscular endurance, overdevelop their hearts, and after they retire from their strenuous activities — as they perforce do while still young — this vital organ rapidly degenerates from disuse into fat. Lungs enormously expanded in a similar way, very commonly shrink and shrivel, forming ideal points of attack for respiratory diseases. The only safe and sane form of athletics is that which promotes harmonious and even development of all the muscles and nerve tissues in the organism.

Beneficent effects of exercise upon certain vital processes. There are certain effects of exercise that are important. These are:

1. *Upon the heart and circulation.* Many middle-aged people and not a few youths excuse themselves from any unnecessary exercise on the ground that they have weak hearts, and are in danger of seriously impairing them by any appreciable physical exertion. It is true, of course, that many people do have weak hearts; in fact, as we saw in an earlier lesson, heart disease in some form or other is now the major cause of death within the registration area of the United States. It is to be remembered, however, that the heart is a muscle, and that the only means we have of strengthening a muscle and increasing its robustness is by exercising it. A generation ago physicians quite commonly prescribed quietude and cessation of all possible physical activity as the proper treatment for a weak heart. Nowadays, however, they are recommending increasingly moderate exercise to those patients whose hearts are not in too bad shape, in the belief that they may be able thus gradually to improve and strengthen them. It appears to be the case that those persons afflicted with weak and irregular hearts, and who refrain from light gymnastics and other forms of developmental activity, are following exactly the procedure that will tend rather to keep them weak or even cause them to grow weaker still, than to energize and improve them.

For persons whose circulatory system is organically sound and unimpaired, regular exercise is indispensable for health and continued efficiency. No one should permit himself through lack of proper physical activity to reach the condition where it is impossible for him to climb a flight of stairs two steps at a time, or to sprint for a car, or otherwise respond to an emergency demand upon the organism, without suffering unpleasant pains or palpitations of the heart. The

only way to maintain this important muscle-pump in vigorous condition is through persistent and regular physical exercise, suited, of course, to the peculiar needs and inclinations of the individual. For most adults, tennis, golf, gymnasium work, hiking, climbing, swimming, rowing, skating, and skiing are among the best prescriptions for health and longevity.

2. *Upon the respiration.* If exercise is essential to the health of the circulatory system, it is equally so to the health of the respiratory system. Confining ourselves to mention of the lungs only, as those parts of the respiratory system most obviously concerned, it is evident that the increased circulation of the blood during increased metabolism passes a greater volume of blood through the pulmonary region, and consequently necessitates deeper breathing in order to aerate it and remove its carbon dioxide content. Under ordinary conditions of non-exercise the lungs operate slowly and somewhat superficially, and without moderate muscular activity the only way we should have to increase their work would be by voluntarily regulating the respiration through some kind of "breathing exercises." The probabilities are, granting even that "breathing exercises" are not dangerous, that they possess no particular value. Certainly they are illogical in the extreme. Increased respiration should be, as Burton-Opitz has pointed out,[1] "an expression of increased respiratory need, and should follow as a response of the respiratory mechanism to the need for oxygen by the tissues of the body."

Well-developed lungs are the result of frequent speeding-up of the whole body machinery in moderately strenuous muscular activity. Puny lungs of low capacity, housed in a narrow, undeveloped chest, stamp a person at once as one who lives an inactive life, or at least who never subjects his

[1] Burton-Opitz, R. *A Textbook of Physiology*, pp. 507–17.

organism to the challenging and energizing test of moderate athletics. For young people, running games, hiking, climbing, and aquatic and winter sports are some of the very finest kinds of 'breathing exercises.' Schools are guilty of having substituted for these natural lung developers an artificial type of exercise which has little to commend it to the minds of sensible people. Small wonder that boys and girls, released from their school confinement, are so eager to run and shout.

3. *Upon the digestive apparatus.* The writer well recalls his initial experiences on a trans-Atlantic liner. During the first two or three days of the voyage, appreciating the opportunity to sit comfortably in a steamer chair and read volume after volume of books that he had long desired to read, he took no exercise beyond an occasional round of the deck. The cuisine, of course, was superb and lavish, and ocean breezes stir up proverbially a stout appetite! Within forty-eight hours his head was aching terrifically, and he was a victim of extreme indigestion. The ship's doctor, in addition to his medicine, prescribed a five-mile walk daily (several hundred times around the deck), and participation in some kind of deck game or dancing, in addition. The remedy was embraced with eagerness, and within another twenty-four hours it had worked a complete cure.

The chronic victim of indigestion is, perhaps nine times out of ten, the chronic victim of inactivity; only the tenth victim suffers from actual functional or structural disturbance of his digestive system. Cells surfeited and often glutted with food; digestive tract sluggish and overworked; circulation hampered and clogged — these are the real physiological causes of a poor digestion. If you would enjoy a good digestion, if you would know the pleasures of eating and digesting without distress — remember the steam-engine boy or the steam-engine girl that you were at ten.

Revive that pristine interest that you then had in games and sports and exercise. Resuscitate your interest in some genuine form of muscular activity, and throw yourself into it with a vim. Poor digestion for the organically sound person is as inexcusable as head lice or gout!

Importance of school playgrounds and equipment. Cultivation of the physical appears, from this lesson, to be as important as cultivation of the mental — indeed, the richness of the latter is to a remarkable degree dependent upon the extent of the former. If this be true, it then follows that it is equally as incumbent upon the school to provide for training of the muscles as it is for training of the intellect. We have noted in a previous chapter (see Chapter I) the close interrelationship between the physical and the mental status of the child. It is hard to see why, appreciating this fact as most intelligent people do, so little provision is made in most schools for outdoor play and games. Rural and village schools, situated where land is relatively low-priced, too often have no adequate space for playgrounds, to say nothing of possessing equipment and apparatus for them. This state of affairs is indefensible. Spacious grounds, laid out for sports and games dear to the heart of every boy and girl, should be provided. These should be available for all-the-year-round use and enjoyment, not only of the school children, but of the young people and adults of the community as well. The day is not far distant when such a recommendation as this will not be regarded as Utopian, but will be religiously carried out by every non-urban school in the land.

In the cities, where the cost of land is high, there is slightly greater justification for the small and wholly inadequate 'yards' that exist in nearly every urban community. Even here, however, it is only a question of relative values, and when it is thoroughly understood that playground space and

equipment are as essential to an all-round and harmonious educational process as are school buildings and school 'supplies,' the money for making possible the former will be forthcoming. As it is, the newer school sites are in many cases being selected with a view of providing for sufficient space for playgrounds; the chief problem lies in securing these for old buildings which were constructed before the cities grew so large, and which are now hemmed in almost to the doors by the encroaching industries and businesses. The probabilities are that only with the passing of these older buildings, and the wiser relocation of schools to occur in another generation, will this evil of cramped and insufficient play-quarters be corrected. In the meantime, it is the high duty of every teacher to preach the gospel of play and playgrounds, and to lend all her influence to its furtherance as new buildings in her community are projected, or as old sites are improved and expanded. Community parks and playgrounds for congested areas, whether or not connected with the schools, merit also the enthusiastic support of the true teacher, who realizes that it is a poor, lopsided system of education that takes no thought of the muscles of boys and girls.

TEACHING POINTS IN THIS LESSON

A. *Structure and Function*

1. Voluntary and involuntary muscles compared.
2. Structure, location, and use of tendons.
3. Antagonistic muscles described and illustrated.
4. Importance of automatic muscular action.
5. Reflex action.
6. Points of similarity between the neuro-muscular mechanism and a doorbell circuit.
7. Physiological causation of fatigue.

B. *Hygiene*

1. How muscles are strengthened.
2. Why muscles in some people are weak and puny.

3. Need for more play and games to-day than a generation ago.
4. Ideal games and sports for boys and girls.
5. Over-exercise and its dangers: importance of moderation.
6. Effects of exercise upon the circulation.
7. Effects of exercise upon the respiration.
8. Effects of exercise upon the digestion.
9. The value and place of playgrounds in a community.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Construct a chart of the human body (drawn not less than ten inches high) and sketch in some of the more important and prominent skeletal and facial muscles, indicating the name of each.
2. Make a study of the three systems of levers recognized by mechanicians, and find types of muscular action which correspond to each. (See especially Reference 1, below.)
3. Make parallel lists of movements involving the following kinds of muscular action: voluntary action; involuntary action; reflex action; automatic action.
4. Write a descriptive page theme on either of the following subjects: "Muscle Innervation"; "The Harmonious Integration of Nerves and Muscles."
5. Make a study of fatigue induced voluntarily in the muscles of the forearm by operating an improvised ergograph of the Mosso type, but without the kymograph tracing. If two students perform the experiment together, one can keep an approximately accurate record of the onset of fatigue in the other by means of a broken line, the upstroke indicating contraction, the downstroke relaxation, and the height of the apices the amount of the contraction; thus:

6. Make a survey of the local school playgrounds, studying especially their size; the number of children dependent upon them; and their equipment. List the different schools in descending order of excellence (a) of size of ground; and (b) of equipment of grounds.

SELECTED REFERENCES

1. Burton-Opitz, R. *An Elementary Manual of Physiology*, chaps. 5, 6, 7, 8.
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3. Pyle, W. L. *A Manual of Personal Hygiene*, pp. 317–39.
4. Williams, J. F. *Personal Hygiene Applied*, pp. 114–46.
5. Wood, T. D., and Brownell, C. L. *Source Book in Health and Physical Education*, chaps. 5, 10.

CHAPTER VI

THE SKELETAL STRUCTURE

1. *Physiological approach*

Vertebrates and invertebrates. All living organisms may be divided into two great groups: vertebrates and invertebrates. The latter class, to which all the less highly evolved types of living creatures belong, includes all biological species which possess no backbone; the former class, to which belong all the more complex types of organisms, including man, is characterized by the presence of a spiny column and other bony structures directly or indirectly attached to it. Members of this last mentioned group — the so-called vertebrates — possess the distinct superiority over the other group of being capable of raising their body from the ground and of locomoting it much more easily and rapidly from one place to the other. The invertebrates, on the other hand, typified by the surging and inert microscopic life of the sea and land, are compelled to limit their range of excursion to a relatively small area. Unable to depend upon self-motility, these primitive organisms must depend upon the force of tides or winds or other external agencies to propel them about in their perennial quest after food and an attractive environment for the reproductive process.

It was very far back in the animal series that certain more active and enterprising forms of animal life began to develop skeletal structures as an aid to climbing higher in the evolutionary scale. We find these bony deposits in the shellfish and the beetle, and even farther down in the series than these creatures. Skeleton frameworks are found all the rest of the way up through the birds and reptiles to the mam-

mals, and in many of them, bone for bone and joint for joint, there exists a strangely striking resemblance to the human skeleton. The arm of a man, the leg of a horse, the wing of a bird, and the flapper of a whale — all owe their motility to bony structures that are almost identical. Man, the supreme culmination of the evolutionary process, is able to use the bones of his skeleton in the performance of skillful acts, and in the finely adjusted movements characteristic of him, by virtue of the fact that along with the development of his skeleton has gone a parallel development in the complexity of his nervous system whereby he is in a position consciously to operate it and to project its movements purposively.

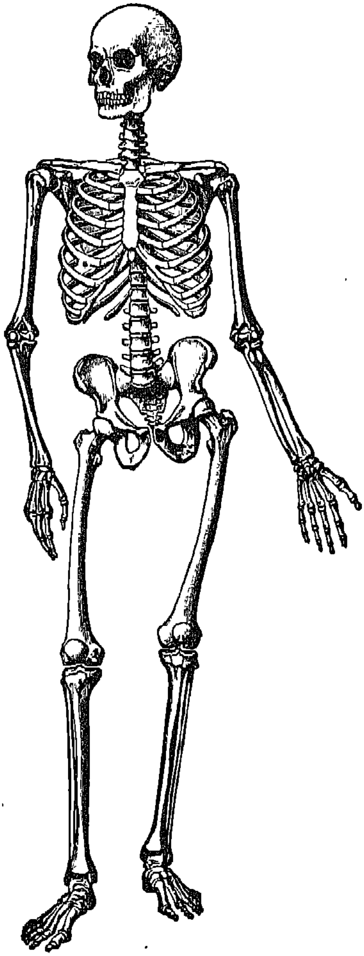

FIG. 16. THE SKELETON OF A MAN

The function of bones. It may be stated that the skeleton serves man in three vitally important ways, viz., first, as a support for his body; second, as a means of protecting

certain vital parts of his body from easy injury; and third, as an agency for motion. Let us examine briefly each of these three functions, and illustrate them concretely.

1. *Support.* As we stated a moment ago, the spineless, boneless organism is compelled to lie prone upon the ground, or upon some buoyant medium which bears it up. If we could imagine the skeleton with all its bones magically withdrawn from a person, we should find that he would collapse in a helpless heap of vainly contracting muscle; there would be nothing in his anatomy more stable than the softest putty or dough. If we could conceive of his attempting to grasp a stick by which to raise himself from his supine position, we would discover that his arms and fingers were completely useless, and that all he could do would be merely to wallow about like a jellyfish, utterly at the mercy of his own helplessness.

Among the chief bones of the skeleton which serve as a means of support and stiffening to the body may be mentioned the *vertebræ* themselves which carry directly or indirectly the weight of head, arms, and legs; the *shoulder-blades* and *collar-bones*, which directly bear the weight of the arms; and the *pelvic-bones*, which directly bear the weight of the legs.

2. *Protection.* It is interesting to study the care and solicitude manifested by Nature for the protection of the vital organs of the body. The very delicate *central nervous system*, comprising the brain and spinal cord, is incarcerated throughout its entire extent in walls of bone. The brain itself is enclosed within the eight hard bones of the skull; the spinal cord runs down from the base of the brain to the pelvic-bones of the hips through a hollow tube fashioned jointly by the twenty-six vertebræ. Only the most violent accidents can shatter these bones and injure the nerve tissues within. The heart and lungs, constituting the two

most vital of all the organs of the body and occupying the entire thoracic cavity, are tightly caged within the twenty-four rib-bones, and are afforded added protection by the breast-bone, the shoulder-blades and the collar-bones. The abdominal organs, less delicate in the sense that they are less delicately responsive to pressure, bending, and other external contacts, are only slightly less completely protected by the bony structures of the pelvis.

3. *Motion.* We are already familiar with the active part played by the skeletal muscles in effecting movements of the body. We have also seen that muscular equipment alone, unsupported by bony structures, is incapable of projecting and accomplishing movements. The motive power in a muscle is unrealizable without the stiffening and guidance provided by the bones to which it is attached. An index of Nature's intent to create in man an organism whose prime function is motility is to be found in the fact that, of the total of two hundred and six bones in the body, one hundred and twenty, or well over one half, are to be found in the arms and legs and their appendages, the hands and feet. These one hundred and twenty bones are distinctly and exclusively to be classified as bones subtending the function of movement.

The tri-partite division of the skeleton. Just as there are three prominent functions of bones, so there are also three geographical divisions or groups under which all the bones may be classified. These are: the bones of the head; the bones of the trunk; and the bones of the appendages, or limbs. In the following paragraphs it is not our purpose to locate and describe all the bones making up these three groups, but merely to call attention to the more important ones whose names and positions any well educated person might be expected to know.

Bones of the head. The bones of the head may be further

subdivided into the bones of the skull, or cranium, and the bones of the face, a total of twenty-nine in both. Of these, the skull contains eight prominent bones, with which, and their relative positions, you should be familiar. The large bone in the forehead is the *frontal* bone; the bone opposite, in the back of the cranium, is the *occipital* bone. Stretching between these two, and extending over the dome of the cranium down to about the top of the ear, are the two *parietal* bones, joined on the top by sutures lying along the median plane. Just below and slightly anterior to the parietal are the *temporal* bones, one on either side of the skull. Joining by sutures to all three pairs of the previously mentioned skull bones, and extending beneath the skull case to form a flooring is the *sphenoid* bone; associated with the sphenoid is another floor bone, the *ethnoid*. The ethnoid bone is not visible in the figure.

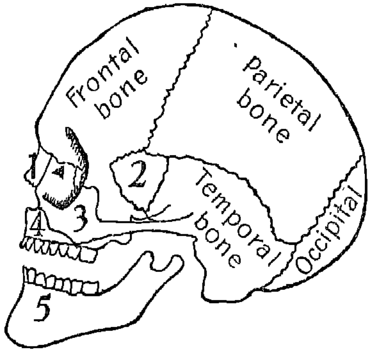

FIG. 17. BONES OF THE HEAD

1, nasal bone; 2, sphenoid bone; 3, malar, or cheek bone; 4, superior maxillary bone; 5, inferior maxillary bone.

Prominent among the facial bones may be mentioned the following: the two narrow *nasal* bones joined in the center to one another and extending down to the bridge of the nose; the two *malar*, or cheek bones; and the *inferior maxillary*, or lower jaw bone, large, powerful and irregular in shape and hinged to the skull just in front of the opening in the ear.

Bones of the trunk. The fifty-seven bones of the trunk

include the twenty-six bones of the vertebra, the twenty-four rib-bones, two shoulder-blades, and two collar-bones, the breast-bone, and the pelvic-bones. The first mentioned group, the bones of the vertebra, are irregular in shape and vary considerably in size, although conforming in all cases to a similar pattern. The anterior body of a vertebra is massive bone, and serves to carry the weight imposed by the vertebræ above it; posterior to this body are the half-rings which form the canal in which the cord is enclosed. The posterior projecting point is called the spinal process, and the two lateral projecting points on the right and left sides of the rings are called the transverse processes. The former processes increase the supporting property of the column; the latter serve as points of attachment for the ribs. A little pad of cartilage rests between each vertebra and its upper and lower neighbors, forming a series of springy cushions which serve to minimize the effects of jarring upon the delicate nerve cells of the brain.

According to their position upon the column, the twenty-six vertebræ are divided into four groups. The first seven

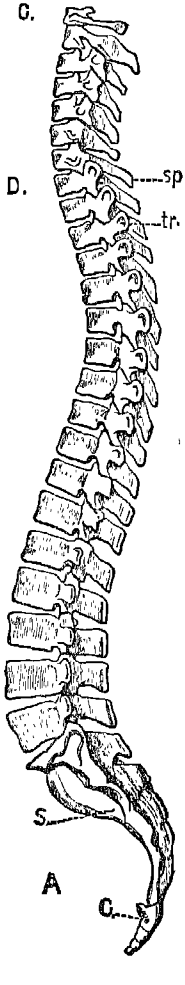

FIG. 18. THE VERTEBRAL COLUMN

Side view, left side; *C*, first cervical vertebra; *D*, first dorsal, or thoracic; *L*, first lumbar vertebra; *S*, sacrum; *C*, coccyx; *sp*, spinous processes; *tr*, transverse processes. (From Coleman's *Elements of Physiology*. By permission of The Macmillan Company, publishers.)

vertebræ at the top of the column, comprising the region of the neck, are called the *cervical* vertebræ; below them, extending downward through the upper back, are the twelve *dorsal*, or *thoracic* vertebræ; the next five below these, constituting those in the small of the back, are called the *lumbar* vertebræ; the next five, lying in the hip region, are called the *sacral* vertebræ. In infancy the sacral vertebræ are separate and distinct, but before maturity is reached they fuse together into a single, very strong bony structure to which the pelvic bones are attached. In tabulating the bones, these five are ordinarily counted as one. Lowest of all in the column, constituting the remains of a rudimentary animal tail, is the *coccyx*, a fusion of four very small bones, all of which are distinct in infancy. Like the five sacral, the four coccygeal bones are tabulated as a single bone.

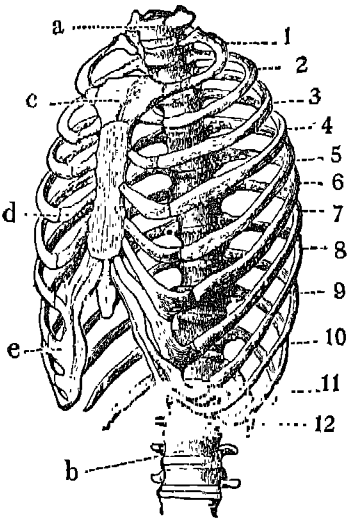

FIG. 19. BONY WALLS OF THORAX

a, b, vertebral column; *c,* sternum; *d,* costal cartilages; *e,* united cartilages of 8th, 9th, and 10th ribs; 11, 12, floating ribs. (From Coleman's *Elements of Physiology*. By permission of The Macmillan Company, publishers.)

By means of this division of the spinal vertebræ, it is possible to designate any one of the twenty-six bones: thus, the third cervical vertebra; the ninth dorsal vertebra; the first lumbar vertebra; the sacrum; the coccyx, etc., etc.

The twelve pairs of ribs are attached posteriorly, as we have seen, to the transverse projections of certain of the

spinal vertebræ. These hoop-like bones are curved in such a way as to encompass the chest cavity as stiffening and supporting walls; they are thin and flat, but very hard, and because of their loose connection in front they are not easily fractured. Like the vertebræ, the ribs are classifiable into three kinds: the *true* ribs, the *false* ribs, and the *floating* ribs. The true ribs, comprising the first seven pairs, counting down from the top of the thorax, are so named because they connect in front directly by means of cartilages to the *sternum*, or breast-bone. The next three pairs do not attach directly to the sternum, but each of their cartilages connects with the cartilage of the pair above, and they are called false ribs. The last two pairs, the floating ribs, are very short and have no cartilages joining them either directly or indirectly to the sternum; their ends are loose or floating, embedded in the muscular structure in the walls of the waist.

The shoulder-blades, one on either side of the back in the thoracic region, are rather thin and flat and somewhat triangular in shape. The shoulder blades are called *scapulæ*. The lower tip of the scapula may be felt readily by reaching the left hand behind the back and feeling with the thumb while the right shoulder is alternately drawn forward and backward. In the upper anterior side of each scapula there is a socket into which fits the upper end of the *humerus*, or arm-bone.

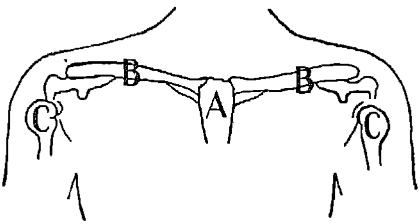

FIG. 20. THE SHOULDER GIRDLE (*front view*)
A, sternum; *B*, clavicle; *C*, head of humerus.

The two collar-bones, taken in conjunction with the two scapulæ, make up what is sometimes spoken of as the *shoulder-girdle*, at whose two outer extremities are attached

the arms. The collar-bones are called *clavicles*. These extend across the front of the thorax, the inner end being in conjunction with the sternum and the outer end joined to the scapula. The function of the clavicles is to aid in holding the shoulders outward from the thorax in order that the arm movements may be free and unhampered. These bones can be plainly seen at the base of the neck, and the line which they form across the top of the thorax can be readily followed out by the fingers from the sternum to the shoulders.

The *sternum* is the irregular-shaped breast-bone, to which we have already referred; it extends from the shoulder-girdle halfway down the thorax, and besides serving as a point of direct or indirect attachment for ten of the twelve pairs of rib bones, it aids in stiffening the thoracic cavity and in protecting the heart from injury.

The *pelvic* bones, by reason of their strange lack of resemblance to anything, are called the *innominate* bones.

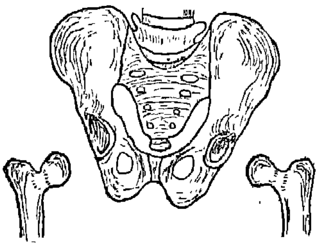

Fig. 21. The Pelvis

When the ancient anatomists first gave names to the bones of the body they could readily trace a resemblance between the collar-bone and a key, and so they gave to it the name 'clavicle'; the shoulder-blade suggested to them a trowel, and so 'scapula' it was called; the coccyx struck them as resembling the bill of a cuckoo, hence the name 'coccyx'; and so on with other bones. But when they came to the two bones forming the pelvis, they could think of no resemblance between them and anything else in the world, and so their very namelessness suggested their appellation: the 'innominate'—name-

less—bones. They may be described in general terms as flat, sturdy, and slightly semi-circular in form. We have already noted the fact that the five sacral vertebræ, distinct in infancy, fuse together during the early years to form the large twenty-fifth vertebra. It is to this that the top portions of the innominate bones are joined, while their lower ends join each other. The basin-like cavity thus formed by the broad, laterally-curving innominate bones, and the outward-curving twenty-fifth and twenty-sixth vertebræ, is known as the *pelvis*. Within the pelvis are contained the bladder and the genital organs.

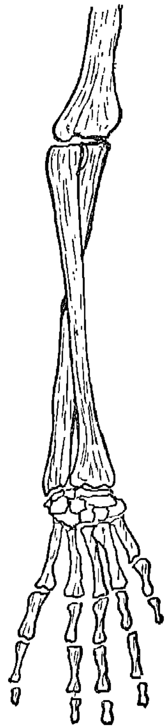

Fig. 22. Arm and Hand

Bones of the appendages. The appendicular skeleton comprises, as we have seen, the bones of the four limbs, thirty to each, and one hundred and twenty altogether. We should be readily familiar with the names of the more important of these bones. Since, however, many of them have group names, identical for both arm-hand and leg-foot appendages, this should not be a difficult task. Let us start with the bones of the arm and hand.

The upper arm contains but a single bone—the *humerus*, joined to the shoulder-girdle above by a ball-and-socket joint. The lower arm contains two parallel bones, the *radius* and the *ulna*. The former is the top bone, when the arm is held thumb-up, while the latter is the under bone felt when the arm is in the same position.

The bones of the hand include eight wrist-bones, five palm-bones, and fourteen finger-bones. The eight wrist-

bones are called the *carpus* bones; these are, obviously, very small, being in infancy only undifferentiated bits of cartilage but slowly during early childhood developing into distinct bony structures. The five palm-bones are known as the *metacarpus* bones; these both give stiffness and strength to the palm and serve as supporting media for the finger-bones. The fourteen bones of the fingers are called *phalanges;* each finger has three, while the thumb has two. Owing to its much more flexible joint attachment the thumb is capable of a considerably wider range of excursion than are the fingers, the latter being limited practically to hinge-like movements in two directions only.

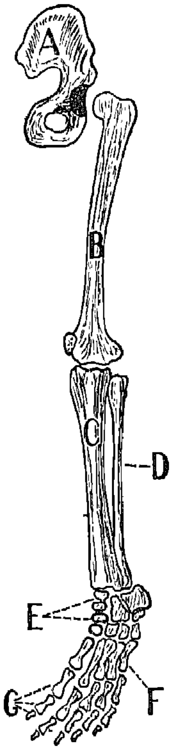

FIG. 23. BONES OF THE LEG AND FOOT

A, pelvic bone; *B*, femur; *C*, tibia; *D*, fibula; *E*, tarsus bones; *F*, metatarsus bones; *G*, phalanges.

The bones of the leg and foot correspond closely in structure and name to those of the arm and hand. The large bone in the upper leg — the largest in the body—is known as the *femur*. Just as the ball of the humerus fits into the socket of the shoulder-girdle, so the ball of the femur fits into the socket of the pelvic girdle in the innominate bones. In the lower leg, as in the lower arm, there are also two bones; these are called the *tibia*, or shin-bone, and the *fibula*, or splint-bone. The former corresponds to the radius of the forearm; the latter to the ulna. The weight of the body bears more directly upon the tibia, in each of whose ends are the joint formations connecting with the femur above and

the ankle-bones below. The fibula is a much smaller bone, and serves as a sort of brace to the tibia. On the knee-joint, firmly secured by tough ligaments in the extensor tendon coming down from the triceps muscle in the upper leg to the tibia in the lower leg, is a bony structure called the *patella*, or knee-cap. This serves as a protection to the knee-joint. It is somewhat circular in shape, and can be readily felt at the knee. Try the experiment of extending the leg and resting the heel upon the floor. Relax the muscles and work the patella up and down. Raise the foot slowly from the floor and feel the tendon over the knee contract and bind the patella firmly down against the knee-joint.

Corresponding to the eight carpus-bones in the wrist are the seven *tarsus* bones of the ankles, the largest of them being the bone in the heel. Below these, and forming the bones of the arch of the foot are the five *metatarsus* bones, corresponding again with the five metacarpus bones of the wrist. Like the latter, the metatarsus bones serve both as a support and strengthener to the instep and as a medium for the attachment of the toe-bones; these are grouped like the bones of the finger, and like them are called phalanges; they are fourteen in number, three for each toe, excepting the great toe, which has but two.

The anatomy of bony structure. The bones of the body comprise two quite different parts — the hard and the spongy parts. In the long bones such as the femur, the hard, dense portions make up the shaft of the main body, while the spongy portions are found in the enlarged ends of the bone. In the smaller, flat bones, such as the ribs, the outside layers of cells are hard while the inner layers are spongy. In the spongy part of bones there is found a red marrow in which the red blood corpuscles of the body are manufactured. You have no doubt observed the presence of this marrow in well-cooked rib-bones of beef.

The long bones are hollow, thus being lighter and stronger than they would be if they were solid. If we were to saw through one of these bones lengthwise, we should find that in the central cavity there is another sort of marrow, quite different from the red marrow observable near the ends of the bone in the spongy parts. This shaft marrow is yellowish, and is composed of fat and blood vessels which aid in nourishing the interior cells of the bone. The outer layers of cells receive some of their nutrition from the *periosteum*, which appears to be a sleek, close-clinging membrane drawn tightly around bones, and made up of blood vessels and connective tissue. Bony tissues are likewise permeated with canals through which the blood vessels pass, bringing nutritive particles to each of the tiniest bone cells in the depth of all bony structures.

Chemically, bones are comprised of about two parts of mineral and one part of animal matter. The former is chiefly lime, while the latter is a gelatinous substance like that found in the hoofs and horns of cattle.

Procure at the market two ribs from a hog. Place one of them in a jar of strong vinegar, or muriatic acid, and leave it for a week. Put the other on a small shovel and burn it in the fire until it resembles charcoal. It will be found that the action of the acid has so removed the mineral matter from the bone that it is flexible enough to tie in a knot; and that the fire has burned out the animal matter, leaving the bone light and easily pulverized. Weigh both bones before and after the experiment. It is the deposit of lime made by the bone cells that make the bone stiff and hard. In infancy these deposits are scanty, and the bones of young children are in consequence rather hard to break but easy to deform or misshape. In old people, the reverse is true.

The joints. The joints of the body, i.e., the points where bones join with bones, are of two types: movable and im-

movable. The latter are notably found in the skull, and are known as *sutures*. As Figure 24 indicates, sutures are irregular joints resembling somewhat the teeth of a saw, the sides of one bone dovetailing neatly into the other. All joints are firmly bound and held together by strands of stiff, inelastic ligaments.

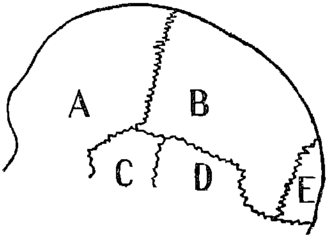

FIG. 24. SUTURES OF THE SKULL

A, frontal bone; *B*, parietal bone; *C*, sphenoid bone; *D*, temporal bone; *E*, occipital bone.

The movable joints are much more prominent and numerous than the immovable ones. These are of several sorts, chief of which are the following:

1. *Hinge joints.* As their name indicates, joints of this kind afford motion only in one direction — forward and backward, like the hinges of a door. Hinge joints are found prominently at the elbow, between the humerus and the ulna, and at the knee, between the femur and the tibia.

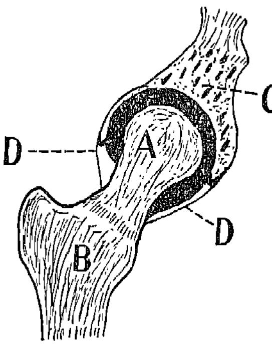

FIG. 25. DETAIL OF BALL-AND-SOCKET JOINT AT THE HIP

A, head of femur; *B*, femur; *C*, pelvic bone split lengthwise to show the cup of the socket; *D*, capsule.

2. *Ball-and-socket joints.* Joints which permit one of the bones concerned to move in all directions are known as ball-and-socket joints. The top of the movable bone ends in a smooth, ball-shaped head, which fits into a socket formed by the other bone. Joints of this order are found chiefly at the shoulder and at the hip. The upper end of the humerus

fits into the socket in the shoulder-girdle, while the upper end of the femur fits similarly into the socket in the hip-girdle.

3. *Pivot joints.* These permit only circular or rotary motion. The head of one bone in such a joint is bound to the other bone concerned by a strap-like ligament which allows it sufficient freedom to be rotated partly around. The joint at the elbow between the humerus and the radius is a pivot joint, which you can readily observe in operation by rotating one hand and feeling the elbow movement with the fingers of the other hand.

4. *Gliding joints.* In the wrists and ankles is another form of movable joint which permits several bones (the carpus and tarsus) to slide over one another. While the movements thus afforded are exceedingly limited in range, they are of importance in making the wrists and ankles flexible and easily adaptable to changes in position. Without them, our hand and foot movements would be very clumsy and uncertain.

While it is true that joints differ thus distinctly in their mode of operation, it should be understood, of course, that they all work harmoniously and permit the body to perform very complex and involved movements. A few moments of thoughtful contortion of hands, wrists, arms, and shoulders simultaneously will reveal to you how free and uncircumscribed are our body movements, permitting the organism to adjust itself without awkwardness to almost any conceivable demands made upon it.

Structurally, a movable joint has several interesting features. In the first place, the uniting bones are cushioned each upon pads of soft, elastic cartilage, which absorbs shocks and jars that might otherwise be decidedly disagreeable and often dangerous to the organism. In the second place, the two bones uniting to form the joint are securely

lashed together by tough ligaments. In severe sprains or dislocations these ligaments are sometimes torn and even broken, producing great distress and serious inflammation. Under ordinary conditions, however, they are strong enough to offer great resistance to external force. A third interesting feature of a joint is Nature's own lubricating oil, which is secreted by a thin membrane, the *synovial membrane*, and supplied to the joint as it is needed. This synovial membrane is in effect the lining of a much thicker covering, called the *synovial capsule*. This, as indicated in Figure 26 fits tightly about the whole region of the joint, like a tight collar, excluding air from it, protecting it, and keeping the synovial fluid within from being exuded and wasted.

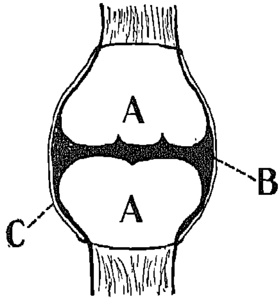

FIG. 26. DETAILS OF A JOINT

A, head of bone; *B*, synovial fluid and cushion of cartilage; *C*, synovial capsule.

2. *The hygiene of the skeleton*

The value of good posture. Turning now from the anatomical to the hygienic side of the skeletal structure, let us first make brief summary of the three fundamental reasons for maintaining the body in its best posture. In the first place, Nature has so designed and arranged the internal organs that unless the body is held properly erect these important organs are in grave danger of becoming cramped, deformed, and even diseased. In the thoracic cavity, the lungs in particular suffer if the shoulders and head are not carried well back. Stooping and careless positions generally very soon become habitual, and so it very often comes about that weak and undeveloped lungs are directly traceable to

persistently slack postural habits formed in childhood and youth. In the abdominal cavity, all kinds of mischief may be done by the crowding of the chest down upon the stomach and liver, and the stomach and liver in turn upon the intestines, kidneys, and bladder. Yet this is precisely what happens when the position of the spinal column is not maintained in a tolerably vertical and erect line, and when the shoulder-girdle is allowed to sag forward and downward.

A second reason for guarding the posture of the body is an interesting psychological one. Those persons who through careless habits of standing, sitting, and walking, become stoop-shouldered, are likely very soon to lose all interest in their personal appearance, if indeed they ever had any. One cannot neglect so fundamental a thing as his posture and have any great amount of pride in the figure he cuts among people. Self-confidence, ambition, determination, and hope go with a fine erect carriage; self-distrust, sluggishness, indecision, and hopelessness, on the other hand, are likely to go with a slouching, indifferent posture. Whether or not there is any cause-and-effect relationship between state of mind and posture, or *vice versa*, cannot be stated. It is a fact, however, that the two are correlated probably very closely and interestingly in our everyday encounters on the streets of men. Especially is it the duty of teachers to have the strictest regard for their posture. They are the representatives of the higher life to the young people who come under their charge, and the higher life does not fittingly express itself in a slovenly posture and a shuffling gait.

The third fundamental reason for cultivating a good posture is for appearance's sake. We are sized up and appraised by others often on the basis of the appearance we make, and the habitual carriage of the body is one of the chief factors that go to make up personal appearance. It is not hard to conclude who of two applicants for a desirable teaching posi-

tion would be chosen by a superintendent, other things being equal, if one of the two was round-shouldered or otherwise posturally careless, and the other was straight and graceful.

Can you think of other values of good posture?

Types of postural defect. Under the general title of postural defects, we generally include two specific deformities: *lateral curvature*, and *anterior-posterior curvature*. The last mentioned is further divisible into two distinct types: *outward curvature*, and *inward curvature*. Before discussing these three kinds of curvature we ought first to point out that not all curvatures of the spine which we find in children and young people are to be thought of as deformities. Hygienists and medical men distinguish between what is called *fixed* curvatures and *functional* curvatures. The former connote a condition of curvature in which the bone itself has become bent or curved abnormally; the latter, the functional type, connotes a condition of apparent curvature in which, however, the bone itself has not yet become deformed, but which is not being maintained in its proper condition by reason of the fact that the supporting muscles are too weak or undeveloped to control it properly. Functional curvatures are found quite commonly in children, especially girls, during the early adolescent period, before the muscles have become sufficiently firm to hold the shoulders back and the abdomen in. With a wise regimen of play and muscular activity, functional curvatures tend ordinarily to disappear before any permanent injury is done to the bony structures. The importance of children striving unceasingly during these years to form good habits of sitting and standing cannot be too zealously insisted upon by teachers. Functional curvatures not then corrected which extend into middle adolescence are almost certain to have become fixed before that time. Correction of fixed curvatures is a far more difficult

and long-drawn-out matter than correction while they are yet only functional in type.

Lateral curvature. This very commonly found type of spinal curvature is known as *scoliosis*. It may be recognized readily by noting whether or not one shoulder is higher than the other. Scoliosis is a condition in which the back presents, instead of a straight line down the median plane, one or more lateral curves, either to the right or left, or to both.

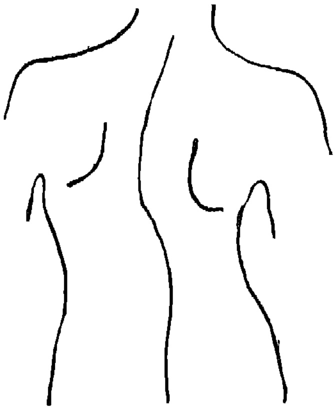

FIG. 27. SCOLIOSIS
A tracing of the left dorsal right lumbar curve.
(*After Lovett.*)

Figure 27 indicates the position of the spinal column in the back of a scoliotic person. This curving of the vertebral column results obviously in pushing one of the shoulders higher than the other, and may also push the hip on the concave side outward out of its symmetrical position.

The effect of scoliosis upon the internal organs is likely to be serious. In the thoracic cavity, the side toward which the spine is twisted is contracted and narrowed down considerably. The lung in that side is consequently constricted at its apex, and does not grow properly, and a most favorable condition is thus developed for the inception of tuberculosis and other pulmonary diseases. Infections in the apices have been found in a large majority of sufferers from scoliosis. In the thoracic cavity also, the heart is handicapped by the unwonted pressure arising from its cramped condition, and it is obliged to work harder because

the tidal air is less in volume and the blood must consequently be circulated through the body at a more rapid rate in order to supply it with an adequate amount of oxygen. In the abdominal cavity, especially in the concave side of the curvature, there is a similar crowding of the organs one against the other, resulting in more friction, less adequate circulation, and less efficient functioning generally.

Causes of scoliosis. Aside from actual bone disease, the most common causes of scoliosis are too high desks, weak muscles, and faulty postural habits. Too much emphasis can hardly be placed upon the proper adjustment of school furniture — especially desks — in the interest of scoliosis prevention. Figure 28 shows a child seated at a desk that is obviously too high for her. In order to write, the entire

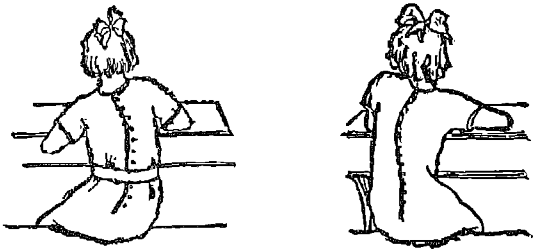

FIG. 28. DESK TOO HIGH. (*After Cornell.*)

forearm must rest upon the desk-top. This means that, in cases where the desk is too high the elbow and right shoulder must be raised by as many inches as the top is too high in order to allow the forearm to move freely across the paper. The left hand, however, whose task is merely to hold the paper lightly in position, does not require the forearm to lie in the same plane with it. Hence the left shoulder offers no resistance to the tendency of the raised right shoulder to depress it so long as the wrist can be bent up over the top of the desk to permit the hand to hold the paper.

Mathematical formulæ have been proposed for determining the correct height, both of seats and desks, but they are *cumbersome* to apply. The most practical method of adjusting consists in having the child sit erect in his chair and place his forearms flat on the desk-top. If in order to do this he is obliged to raise his shoulders, the top is too high; if, on the other hand, his shoulders and upper back are permitted to droop by this position, the top is too low. Adjustment should be made to the point where the child is able, sitting upright in his chair, with his hips back against the rest, to move his arms backward and forward in an anterior-posterior line across the desk-top without necessitating raising or lowering of his shoulders. It is obvious, of course, that the chair itself must first have been adjusted, so that when the child sits back erect in it his feet rest flatly upon the floor, and so that there is no appreciable pressure between the end of the seat and the under part of the child's legs. Pressure at this point will retard the circulation in the lower legs and feet, and tend soon to make the pupil restless and uncomfortable.

This matter of the proper adjustment of desks and chairs does not yet receive the attention from teachers which it ought to have. There is a grave difference between *adjustable* school furniture and *adjusted* school furniture; not always is the former identical with the latter.

Another cause of scoliosis is weak and undeveloped muscles, as we mentioned before. Despite their best efforts, and notwithstanding the chiding of parents and the censuring and scolding of teachers, many children do not have the adequate muscular development to maintain good posture. This deficiency in muscular energy may be due in some cases to some form of malnutrition, and in others to lack of proper exercise and physical activity to strengthen and harden the muscles. The former condition is, of course, much more

difficult to diagnose and correct. In some children it may be due to insufficient food; in others, it may be due to improper diet; in still others, it may be due to a constitutional weakness of the assimilative powers that the best of care and treatment are very slow indeed in fathoming. Muscle tissue is peculiarly dependent upon good nutrition for health and firmness, and where this is lacking — whether because of bad dietary or bad constitution — it suffers in consequence. The other condition, lack of sufficient physical activity to develop the musculature, is ordinarily more easily corrected. Do you know any parents who hesitate to permit their children to indulge in good developmental games and sports, or any children who, because of this unfortunate parental attitude, are muscularly and physically below par? Quite regardless of whether their condition is due to nutritional deficiencies or to lack of physical culture, children whose muscles are puny and flabby have not the strength to maintain correct bodily posture, and so they easily and naturally fall into very reprehensible habits; and twisted, laterally curved spines result quite as commonly as round shoulders from this cause.

Still another cause of scoliosis is to be found in the proverbial carelessness of young people in matters of carriage. Under this classification are not included those who are lacking in muscular strength, but rather those who, possessing adequate muscular energy, refrain from expending a sufficient portion of it upon their skeletons to hold them in superb position. Most teachers in lower and intermediate grades, and even in junior and senior high-school grades, spend a considerable portion of every day, in the aggregate, talking to their children about their posture, condemning here and demonstrating there. One sometimes wonders what the effect would be upon a generation's physique if in its molding period in the schoolroom years before, kindly,

solicitous teachers had not insisted day after day and year after year upon the formation and the maintenance of good postural habits. All kinds of motives have been and are appealed to in the schoolroom in the perennial efforts of teachers to improve the posture of boys and girls; some of these are good; some are bad; some are indifferent, and bring about indifferent results. Most of them, we hope, actually succeed in cajoling children into building finely erect bodies, although their inclination and most of their instincts tend to favor disregard of carriage, and a following of the line of least resistance.

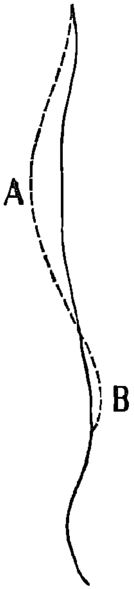

FIG. 29

Showing natural curves of the spinal column in the anterior-posterior plane (as seen from the side); also exaggerated kyphotic curve backward in the dorsal region (*A*), and forward in the lumbar region (*B*), producing a round, hollow back.

Round-shoulderedness. This next most commonly recurring type of spinal curvature is known as *kyphosis*. As its more popular name indicates, kyphosis is a rounding down of the shoulders, due to an outward curvature of the spinal column, more often in the mid-dorsal region. Typically, the kyphotic child presents, in addition to an exaggerated and pronounced curvature of the spine at this point, a chest noticeably low and flattened.

The effect of kyphosis upon the internal organs is similar to that produced by scoliosis. Depression of the chest tends to reduce the capacity of the upper cavity, resulting in crowding and constricting the lungs and heart. Adhesions of the pleura, lack of complete development, and susceptibility to tubercular infections, are thus fostered. The work of the heart, thus unnaturally cramped, is made more difficult to perform; the resistance which it meets from the anterior portion of the chest wall is increased; it is compelled to

work harder in order to maintain the proper balance of oxygen in the body, as we saw in a preceding paragraph. The abdominal organs of the viscera suffer the same form of crowding downward from above in kyphosis that they are subjected to in scoliosis, the chief difference being that the pressure from the organs above the diaphragm is more evenly distributed upon all the abdominal organs than is the case with scoliosis, and these organs, instead of being cramped laterally are cramped anterior-posteriorly. Either sort of cramping is equally bad.

Aside from an actual diseased condition of the vertebral column or other bones of the trunk, kyphosis in children is commonly due to one or another of the following causes: too low desks; weak muscles; and faulty postural habits. The two last mentioned causes of spinal deformity have been already discussed sufficiently under scoliosis, and do not require additional treatment here. It is obvious that weak muscles, whether due to malnutrition or to lack of physical culture, and faulty postural habits, may as logically lead to round shoulders as to lateral curvature, depending upon the habitual position the body is inclined to assume. Of the third cause of kyphosis, however, low desks, an additional word needs to be said.

When a child sits at a desk that is too low for him, he is compelled to lean forward and bend his shoulders down in order to rest his arms upon the desk-top. A position of this sort, frequently assumed as it necessarily is during a school day, cannot but foster the formation of very undesirable and unhygienic habits of posture in any child, however persistently he may strive against it. There is a strong temptation for a child thus seated at a desk too low for him when he is engaged in study to slide forward in his seat, so that the weight of his body falls upon the tip of the spine, and so that his neck is supported against the back of his chair; this

throws the vertebral column into a distinctly concave position, which quite easily leads to kyphosis, besides endangering the vital organs through displacement and compression.

Inward curvature of the spine. In this form of curvature, known as *lordosis*, the vertebral column curves inward. Its usual cause is disease of the bones or of the hip-joint. Lordosis occurs much less frequently in children than either scoliosis or kyphosis; we shall therefore not discuss it further than to describe the nature of the bone or hip diseases which cause it.

Diseases of the bones and joints as causes of spinal curvatures. Important as are careless postural habits in producing spinal curvatures, they are by no means either the most insidious or the most common causes. The majority of deformities are due to actual diseased conditions of the bones or joints involved, or of both. We may distinguish two types of diseases of this sort: rickets and tuberculosis.

1. *Rickets.* This is probably the most common single cause of deformities in bony structures, including the vertebral column, and other bones of the thoracic skeleton, and the legs. Rickets is diagnostically a form of malnutrition in which the bones are the chief victims, and is a common cause of the severer types of deformity. This disease has usually fastened itself upon infants before they have passed into their third year, and it appears to be the evidence from studies reported that not far from ten per cent of the school population have been affected to the extent of presenting deformities of legs, back, or chest directly traceable to rickets. Children who have been attacked by rickets ordinarily show as other effects of its ravages disproportionate and unsymmetrical development of the body parts, particularly in a considerably overgrown head and enlarged

joints. The bones of the ribs are knotted in contour, and the chest presents the appearance of having been pinched laterally so that the breast bone is pushed out into prominence. This aspect of thoracic deformity is commonly known as 'pigeon breast.'

In the interest of prevention of rickets, it appears to be important that the proper dietary for a child be established as quickly as possible, and that his nutritional demands be met consistently throughout the early years.

2. *Tuberculosis*. As we shall learn more in detail in a subsequent chapter (see Chapter XII) tubercular bacilli can and do attack commonly other organs of the body besides the lungs. Next to the pulmonary system, these germs seem to favor bones as a culture medium, attacking most typically the spinal vertebræ, the hip, and the bones of the leg. Children who harbor this infection in their bony structures are doomed almost certainly to a life of suffering and gross body deformity. The preventive measures for tuberculosis will be discussed in Chapter XII. Their importance as a means of safeguarding the child against the misfortunes of a twisted body and a very much circumscribed life are too obvious to need more than the bare mention here.

Other lesser causes of curvature. Among the lesser causes of spinal curvatures may be mentioned poor vision, which necessitates habitual bending or stooping over school work; defective hearing in one or the other ear, which tends to cause an habitual torsion of the body so that the better ear will be always presented to the sound waves; accidental causes, such as being dropped in infancy, uneven extremities, etc.; improper manipulation of breaks and dislocations; and the carrying of burdens habitually on one shoulder in preference to and to the exclusion of the other.

Maintaining the proper poise of the body. From what

we have learned in this and the preceding lesson, it is evident that habits of correct posture of the body are of the highest importance in maintaining the organism in health and serenity. It will be wise, therefore, for us to pause a moment to describe what constitutes good posture in sitting, in standing, and in walking. Few lessons on health habits to boys and girls are of more importance than are those which inspire and persuade them to take pride in their posture at all times. As we have seen, the bony structures are notably soft and pliable in childhood; hence the importance of leading school children to form good habits of posture while they are still young.

In sitting in a chair, it is important that the hips be kept as far back as possible, and that the trunk be held erect — not exaggeratedly, but comfortably — so that the head of the back-rest comes just underneath the lower tips of the scapulæ. This position should be maintained religiously; this should not be found difficult provided the abdominal and back muscles are kept in proper tone, and the feeling of ease and what may be termed 'internal spaciousness' will be very agreeable indeed. It is to be assumed, of course, that the chairs are adjusted to the proper height, and the back-rests have been set at the correct position. One should never permit himself to slide forward in his seat and ease his scapulæ against the chair-back. This position not only compresses the thoracic and abdominal organs, but gives the impression of sluggishness and even laziness. When our work has become so irksome, or has been so long continued, that the correct posture described above can be no longer maintained, we should terminate it and turn to some other task of a nature sufficiently different to rest and refresh us. The hygiene of the school program has not yet been satisfactorily worked out, but, as we shall see later on (Chapter XII), it is highly important that the school

schedule be so arranged as reasonably to safeguard the children against the onset of fatigue and discomfort by providing scientifically for the best succession of studies and wise introduction of recesses and calisthenics.

The standing position assumed by pupils in the schoolroom, especially when called upon to recite at their desks, is often extremely reprehensible. An observer is obsessed with the idea that either children are naturally too lazy to stand squarely and boldly, or else that they lack confidence in themselves, their teacher, or their lesson. The writer, time and again in his peregrinations through the schoolrooms, finds children, supposed to be standing and reciting, lolling over their desks like infants, with one knee on the chair and one or both arms or hands on the desk. Small wonder that children who are thus permitted to lounge through school like invalids can rarely be heard by two thirds of the other pupils as they murmur over some indistinct response that is lost before it reaches any ears save those of the teacher, attuned too indulgently by long practice to perceive what a child means or what he knows while he is yet stammering about it. It is of extreme psychological importance, in order that a pupil may learn to arrange and unify his experience, and to present it or defend it plainly, concisely, almost defiantly, that he shall be taught to assume rather an aggressive than an apologetic manner; clumsy lolling is no more aggressive than erect, square-shouldered posture is apologetic. The body attitude is only little less aggressive than speech. Animals are quadrupeds: man should be a biped, and should glory in his high estate.

In an easy and graceful standing posture, the head is held in the vertical plane, neither at an angle forward nor backward out of that plane; the shoulders are held up and thrown back moderately, though not extremely; the chest is drawn upward without being thrown forward; and the

weight of the body is balanced easily upon the balls of the feet. Bent heads, flat chests, and protruding abdomens are neither attractive nor hygienic. In prolonged standing, one foot may be advanced slightly, but the unsightly and equally unhygienic standing on one foot should be avoided, when this position is assumed, by distributing the weight of the body tolerably evenly between the two feet. If one foot alternates with the other in the advanced position, momentary relaxation and resetting of the muscles will be provided for, and the onset of unpleasant or extreme fatigue will be retarded.

Walking is a fine art which only relatively few acquire with grace. Shuffling along with head inclined forward, shoulders drooped, and with one foot dragging half-heartedly and reluctantly after the other, is unworthy of any healthy and self-respecting person, besides being more fatiguing and de-energizing than walking in good form. If you study the gait of the pedestrians passing a given point during a five-minute period you will see all kinds of parodies upon walking. There will be the scuffler, the shuffler, the waddler, the hitcher, the sloucher, and all the other varieties of performers in the pedal art. For every passer-by who walks gracefully and easily there will be at least two, and more likely half a dozen others, who manifestly neither themselves experience pleasure in walking nor give evidence of ever having really learned to *walk*, although they have been self-propelling for years.

Easy and exhilarating walking posture demands that the head be held up, the chest carried high, the arms be swung freely though not emphatically at the sides, the weight be supported upon the outer side of the feet, and that the feet be kept almost parallel, the toes just perceptibly inclined outward from the anterior-posterior line of the body. With the body maintained in this position, walking be-

comes not only graceful and beautiful, but exhilarating as well — provided always that the pace set is as rapid as can be kept up without unpleasant exertion. There is no exercise suitable to all climates and all seasons quite so excellent as walking, and it is a matter to be regretted that many people have never trained themselves to follow it as one of the fine and gentle arts, and to find enjoyment and refreshment in it.

The hygiene of the feet. Another part of the body that suffers frequently from functional deformity is the foot. When one stops to reflect that every time he takes a step, the entire weight of his body is thrown upon a foot, and that for an adult weighing 125 pounds this means a gross burden of something more than 100 tons borne by his feet every mile that he walks, he can appreciate something of the importance of sensible and even solicitous care of his feet.

'Flat-foot,' in some degree or other, is a malady with which very many persons are afflicted. Naturally the tendency to flat-foot is more common in those who are stout than in those who are slender, and in those who lead active physical lives than in those who pursue a sedentary occupation. This disorder is variously called 'flat-foot,' 'pronated arch,' 'fallen arches,' and 'broken arches.' The last mentioned is peculiarly inappropriate, for there is nothing 'broken' in flat-foot. The whole difficulty lies not in an anatomical disorder of the bones of the foot, but in a relaxation and pronating of the muscles by which the arch of the foot is normally preserved. This being the case, leaving out of the question those who are harder on their feet than others, it follows that the development of fallen arches must be due to some factor or factors which serve to weaken the muscles of the leg. Savages who wear no shoes or only loose sandals, are not known to be troubled with flat-foot. The only difference between the feet of savages and the feet of civilized people lies in the fact that the former have never

been subjected to the wearing of shoes. This would seem to indicate that wearing shoes favors the development of this disorder.

There are two evils in the shoes of civilized people that account for practically all the cases of fallen arches from which they suffer. The first of these is the insecure foundation of the shoe, and the other is the excessive narrowness of the shoe. To support the foot and ankle properly, the sole and heel of a shoe must be broad enough to prevent the ankle from 'rocking' from side to side. If the heel is excessively high as well as narrow, the whole foot will be unsteady and the muscles of the leg will be subjected to too severe a strain in their attempts to hold the foot on its outer edge, the springiness will be lost from the arch, and the foot will roll inward. Severe aching sensations not only from the ankles and feet, but extending up into the legs and even the back, ordinarily accompany relaxation of these muscles in their fighting of a losing battle against pronation. If the shoes worn are narrow and tight, they will compress the instep and paralyze the small muscles there found, and increase the probability of a speedy development of fallen arches.

In the interests of prevention of this disagreeable and painful affliction, it is of great importance that care be exercised in the selection of one's shoes. Teachers are among those workers who of necessity stand a great deal on their feet, and it is especially important for them, even before they enter the profession, to form wise rules with respect to the shoes they wear so that their work later on will not be handicapped by such wretched and largely unnecessary affliction as fallen arches.

To be comfortable and hygienic, the shoes worn should have a broad sole and an interior sufficiently roomy to enclose the feet without crowding or compressing them. They

should allow perfect freedom for the toes to bend without friction, and for the foot to broaden out freely when the weight is alternately conveyed to it in walking. The heels should be reasonably wide, and not much in excess of an inch in height, topped with rubber. They should never be allowed to 'run over,' but should be either repaired or discarded when they no longer possess the requisite firmness needed to hold the foot squarely and evenly. Low shoes are always preferable to high shoes, except of course when climatic conditions require otherwise. Sandals or shoes with extremely low heels are as much to be avoided for steady and habitual wear as are shoes of the opposite type.

TEACHING POINTS IN THIS LESSON

A. Structure and Function

1. Vertebrate and invertebrate organisms.
2. The chief functions of bones.
3. Animal and mineral constituents of bone.
4. Red and yellow marrow.
5. Types of joints found in the body.

B. Hygiene

1. Some practical values of good posture.
2. Round shoulders.
3. Uneven shoulders.
4. Schoolroom conditions favorable to poor posture.
5. How to adjust our desks and chairs.
6. How to carry books and other burdens.
7. The correct sitting posture.
8. The correct standing posture.
9. The correct walking posture.
10. The right kind of shoes to wear.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Look up and report in writing the names and habitat of the first species of animals to develop the back-bone. What preceded and followed these?
2. Classify under their appropriate heading all the joints you can locate on the skeleton.

3. Procure two bones at the market — sheep's ribs will be excellent. Place one of them in a solution of muriatic acid, or of vinegar, and allow it to remain until it becomes pliable. Burn the other one in a small stove-shovel. Analyze your results in writing.
4. Grade your own posture on the scale of ten. Ask others of your classmates to grade you also. If time permits, it will prove interesting to have each student grade all the other students in the class, depositing the estimates with the instructor, who will report those having the best posture by popular vote, and those who need to improve upon their posture.
5. Familiarize yourself with the work being done in the nearest tuberculosis sanitarium in the treatment and care of patients suffering from tuberculosis of the bone. If possible, let some member or members of the class visit the institution and report back their findings.
6. Make an honest comparison of the measured length of your bare foot and the length of your shoe; of the width of your bare foot under the weight of your body, across the little toe joint, and the width of your shoe at that point. What do you conclude?
7. Assist in adjusting the desks and chairs of the children in some grade of the practice school.

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2. Pyle, W. L. *A Manual of Personal Hygiene*, sec. 8.
3. Terman, L. M. *The Hygiene of the School Child*, chap. 7.
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CHAPTER VII

AËRATING THE ORGANISM: THE RESPIRATION

1. *Structural approach*

Why we breathe. We are now to turn our attention to the respiratory mechanism by which the body is enabled to abstract the necessary amount of oxygen from the air, and to return to it the carbon dioxide formed in the body during oxidation. As every one knows, when the air is entirely shut off, or when its oxygen content is lowered and its carbon dioxide content correspondingly increased, the organism can no longer survive. Cutting off the air for only a minute or so means certain and immediate death. A few minutes of breathing air that is being contaminated by carbon dioxide suffice also to bring death. It is obvious, therefore, that the integrity of the respiratory process and the relative purity of the air inspired must be guaranteed every moment of our lives if we are to survive.

But why do we breathe? Why do plants, and amœbæ, and fishes, and all animals breathe? The answer is very simple indeed. Every living cell of whatever sort requires a continuous supply of oxygen in order that it may do its work. This oxygen, brought into the biological cell by the blood stream, unites with the nutritive elements therein contained and causes them to be consumed and to impart to the cell their energy and warmth. But for this constant influx of fresh oxygen, the life of the cell could not be maintained for five minutes. And but for the supplementary removal of the poisonous carbon-dioxid by-products of oxidation, and the freighting of it by the blood and lymph canals to the lungs, the cells would become in a short while so clogged and permeated with this deadly gas that death would result.

The air route to the lungs. Let us first trace out the route followed by the air we breathe in from the time it enters the nostrils until it passes from them in exhalation. From the nostril the air passes upward through the nasal chambers, which are well supplied with blood vessels for warming it as it is drawn over them, and with ciliæ which remove from it any dirt particles that it may chance to contain. Thence, passing downward, the air enters the pharynx, a part of which is visible in the back of the throat. It makes no difference whether one breathes through his nostrils or his mouth: the air in either case must pass into the pharynx. From the pharynx it is drawn downward over the larynx and through the windpipe, or *trachea*. The trachea divides shortly into two branches, one passing in the direction of the right lung, and the other in the direction of the left. When the branches of the trachea enter the lungs they are termed *bronchi*, and once inside the lungs these bronchi branch multitudinously into *bronchioles*, each of which finally terminates in a number of small elastic cells, called *alveoli*. The inspired air is, then, drawn down into and expands these thousands of tiny air-sacs. This requires but a second or two, but during it the process of osmosis takes place, some of the oxygen admitted exuding into the capillaries and being replaced by carbon dioxide. The air then passes outward from the lungs along the same route that it followed during inspiration a second or so before. Let us now discuss more fully some of the structural peculiarities of the respiratory passage.

The nose. Structurally, the nose comprises two air chambers which extend upward, backward into the skull, and thence downward to the roof of the mouth, where they terminate in the naso-pharynx. The two nostrils are separated in their upper and back parts by the *septum*, a bony partition formed by parts of two bones, the *vomer* and

the *ethnoid.* The front part of the septum, arising from and joined to the vomer and ethnoid, is cartilaginous, as may readily be demonstrated by moving the nose to the left and right with the fingers. The remainder of the confining wall of the nasal cavities is made up of the so-called *turbinated* bones, three to each nostril.

The mucous membrane lining the nasal passages is well supplied with nerve filaments, especially those subtending the sense of smell, and with blood vessels for warming the air inspired. It is kept moist by a network of glands which, assisted by the heat imparted by the blood vessels, raises the humidity of the incoming air to approximately two thirds saturation by the time it has passed through the chambers. The mucus secreted by these glands is also germicidal in character, and plays an important rôle in excluding dangerous microbes from the organism.

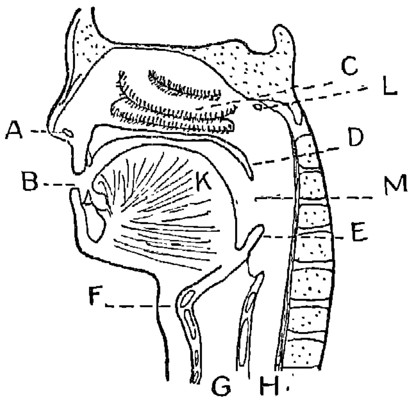

FIG. 30

Showing the openings into the pharynx. *A*, the nostril; *B*, the mouth; *C*, nasal passages; *D*, the uvula, *E*, the epiglottis; *F*, the larynx; *G*, windpipe; *H*, œsophagus; *K*, tongue; *L*, Eustachian tube; *M*, pharynx.

The pharynx. Strictly speaking, there are two pharynxes: the nasal pharynx, called the *naso-pharynx,* and the oral pharynx. The former is really the open space just behind and above the soft palate, into which the nasal cavities open from above. The soft palate, extending downward in front, obstructs the view of the naso-pharynx just behind, but it is readily seen by means of a laryngeal mirror.

The part of the throat that can be seen by opening the mouth wide and looking into a glass is the pharynx proper, or the oro-pharynx. Structurally, it is continuous with the naso-pharynx, being designated as the oro-pharynx merely for geographic purposes.

The back wall of the pharynx, both nasal and oral, is formed by the vertebræ of the neck. Into the pharynx there open the two nostrils, the two Eustachean tubes from the middle ears, the trachea, the mouth, and the gullet or œsophagus, which leads to the stomach — seven important avenues. It should be noted that the trachea extends downward into the neck anterior to the gullet, or food tube.

The larynx. Just at the lowest part of the pharynx is placed the larynx, or voice-box. We may think of this structure as the communicating chamber between the pharynx and the trachea. In many people, especially men, the anterior portion of the larynx may be seen and felt, and is popularly spoken of as "Adam's Apple." Structurally, the larynx is comprised of several cartilages, the largest of which is the *thyroid*. This extends across the front part of the box and is prominent in the neck. The *cricoid* is another cartilage, which articulates with the thyroid and lies below it, forming the first ring of the trachea. Besides these two prominent cartilages, there is another above both: the *epiglottis*. In addition to these three, there are at least two others, known as the *arytenoid* cartilages.

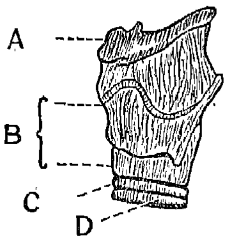

FIG. 31. THE LARYNX (*seen from the left*)

A, front of hyoid bone; *B*, the larynx; *C*, first ring of trachea; *D*, second ring of trachea.

The epiglottis serves as a sort of 'trap-door' to protect the lower respiratory passage from the entrance of food.

Sometimes we 'swallow the wrong way,' which simply means that the epiglottis has not responded quickly enough, and that a morsel of food has gotten past it into the rings of the trachea instead of following its proper route into the œsophagus. In such a situation, Nature expels the foreign matter by means of a violent cough, which is ordinarily forceful enough to drive it back into the pharynx.

The arytenoid cartilages rest on the cricoid and provide the back point of attachment for the vocal cords. The muscular equipment of these cartilages is such that they can be moved backward, in the first place, away from the thyroid, which forms the anterior point of attachment for the cords, and so increase or diminish the tenseness; and in the second place it is such that the arytenoids can be moved closer together or farther apart, thus increasing or diminishing the distance between the posterior ends of the vocal cords. During ordinary breathing, the arytenoids are relaxed, and the vocal cords assume an angular position, similar to that illustrated in Figure 32. During speaking,

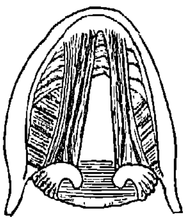

FIG. 32. THE LARYNX
Showing the angular position assumed by the vocal cords when resting.

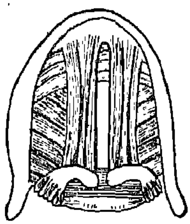

FIG. 33. THE LARYNX
Showing the tense, parallel position of the vocal cords during phonation.

the arytenoids are contracted and the posterior ends of the vocal cords are drawn together, giving the cords the parallel appearance shown in Figure 33.

The voice. While we are concerned with describing the

respiratory mechanism, we may properly pause for a moment to familiarize ourselves with the anatomical and physiological features of the human voice. As we have already seen, the vocal cords are stretched in an anterior-posterior line across the larynx, between the thyroid cartilage in front and the arytenoid cartilages in the back. Sounds are produced by the vibrations of the vocal cords, which are moved close together and drawn tense during phonation. The more tensely they are drawn, the higher the pitch; and conversely, the more loosely they are held, the lower the pitch. When one is excited, he screams; when drowsy or passive, he only murmurs. Nature has also a second means of raising the pitch of the voice besides the mere tightening of the vocal strings; she can raise the level of the whole laryngeal box in the pharynx, thus diminishing the length of the trumpet and so raising the pitch. In low tones, the larynx descends; in higher tones it rises; this action can be readily felt with the fingers.

The vocal apparatus has been appropriately likened to a wind instrument, like the trumpet. The lungs are the bellows which supply the blasts of air needed; the vocal cords are the vibrating membranes; and, if we take the trombone as a type of wind instrument, the position of the larynx may be likened to the extent of the slide. Thus also, just as the quality or timbre of a wind instrument is determined by the shape and character of the portion of the instrument beyond the reeds, so the timbre of the human voice is determined by the phonating chambers in the nostrils. If we detach the lower portion of a trumpet just beyond the reeds, we shall be able to produce upon the reeds only very harsh and unmusical sounds; in the same way, if the nasal chambers are obstructed, the human voice sounds harsh and unpleasant. It is these resonance chambers which really give beauty and harmoniousness to the voice. 'Talking through the nose,'

as one does when one has a cold and the chambers are obstructed with mucus and phlegm, is in reality talking without the nose!

Have you ever stopped to think of the individual peculiarities of voice in your friends and acquaintances? Some of them have pleasing voices; others have decidedly unpleasant ones; some are clear and well modulated; others are raucous and harsh; some are melodious; others are rasping and irritating. Teachers, of all people in the world, need to cultivate pleasing, even musical, voices, for there is nothing more charming to children than a pleasant, melodious voice in their teacher.

The trachea. As we have said, the top ring of the trachea is formed by the cricoid cartilage of the larynx. The trachea itself consists of a series of cartilaginous rings or hoops, about three quarters of an inch in diameter and approximately four inches long, extending from the larynx to the bronchi. These rings of cartilage are sufficiently stiff to prevent the trachea from collapsing under the pressure attendant upon the respiratory processes; they may be plainly felt in the front of the neck.

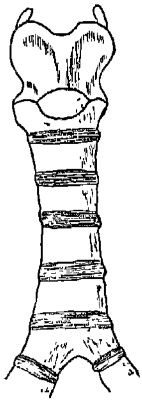

FIG. 34. THE TRACHEA

The bronchi and bronchioles. Immediately back of the upper end of the sternum and opposite the fourth dorsal vertebra the trachea divides into two smaller tubes, called the bronchi. These are, like the trachea, composed of cartilaginous rings. One bronchus passes within the left lung; the other — the larger — enters the right lung. Immediately upon their entry into the lungs, the bronchi divide multitudinously into smaller and ever smaller tubes, which are called bronchioles (small bronchi). The larger bronchioles are stiffened

with cartilaginous rings or plates, but as they penetrate deeper and deeper into the recesses of the lungs, they lose their cartilages and present only circular muscle fibers. These ever-narrowing bronchial tubes completely fill the lungs, branching from one another like the branches of a tree. Each tiny bronchiole finally terminates in a small pear-shaped chamber, called a lobule, in whose walls are a large number of tiny air cups or air cells, the alveoli. It is these myriads of cups which are dilated by the inspired air in respiration, and which swell out the chest as they fill, causing it to fall again as they empty in expiration. Figure 36 shows the schematic appearance of a lobule with its air cells. The alveoli are so tiny that they average only about 120 μ in length, and it is estimated that there are at least four hundred millions of them in each lung.

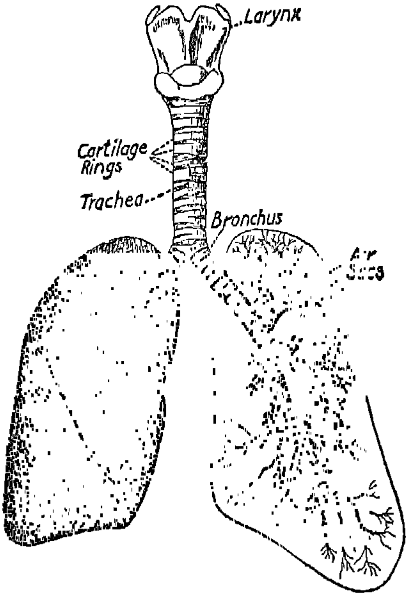

Fig. 35. The Lungs

Upon the left is shown the lung from the outside; upon the right the lung is opened to show the branches of the air tubes. (From *Elementary Physiology and Hygiene*, by H. W. Conn, published by Silver, Burdett & Company.)

The most striking thing about the alveoli is their supply of blood, the greater part of their walls being composed of a very dense network of capillaries. Indeed so dense is this

network about each alveolus that if the entire pulmonary capillaries were laid out flat, they would cover an area of approximately three hundred square feet, or about one hundred times as much as the entire surface of the adult body. The function of the air cells of the lungs may then be understood to be to bring the oxygen in the inspired air into proximity to the de-oxygenized blood in their walls and make possible the replacement of the impure carbon dioxide with fresh oxygen, through the chemical process of osmosis. Thus, when the blood from the pulmonary artery of the heart enters the lungs, it is de-oxygenized and impure; when it emerges from the lungs a few seconds later on its way back to the heart for recirculation it is oxygenated blood. Before it passed through the alveoli walls it was purple with its burden of carbon dioxide; emerging from them, it is scarlet and fresh with its oxygen content.

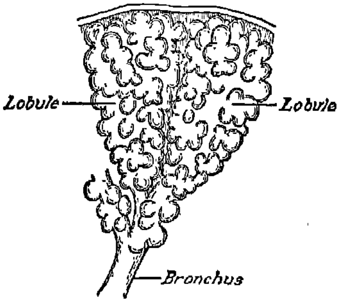

FIG. 36. TWO LOBULES AT THE END OF A BRONCHIAL TUBE

(From Williams's *Healthful Living*. By permission of The Macmillan Company, publishers.)

The lungs. The lungs are not, then, huge elastic bags, like water-wings, which bulge out as a mass with each inspiration, and collapse again with each expiration. They are rather two highly complicated chambers, filled with bronchi, bronchioles, alveoli, veins, arteries, and capillaries. These intricate tubes and sacs are covered over and held in place by a smooth membrane, called the *pleura*. This sleek, serous membrane turns backward from the base of each lung and lines the whole inner surface of the chest wall. Thus, there are in reality two pleuras, one forming an

outer covering for the lungs, the other an inner covering for the chest. The two pleuras are in closest contact with one another, but they are so smooth and sleek that no friction is generated as they glide over one another during the respiratory movements. Both surfaces are kept oily and serous by a secretion called the *pleural fluid.*

Structurally, the lungs are comprised of five lobes, the right lung having three, and the left one two. Since more than half the bulk of the posterior portion of the heart hangs in the left half of the thoracic cavity, there is less space available for the left lung than for the right. For this reason the right lung is appreciably larger, being comprised of three distinct lobes, while the left lung, comprising but two lobes, is distinctly smaller. In infancy and childhood the pleura is pinkish in color, but in maturity and old age the lungs appear much grayer and darker; especially is this modification of color of the pleura characteristic of the lungs of persons who pass their lives in cities or in other environments where the atmosphere is laden with smoke and dust. Another interesting structural fact concerning the lungs is the peculiar elasticity of the alveoli; this is due to the nature of their walls, which are constructed of connective tissue that is much more elastic than most of the rest of such tissue found in the organism.

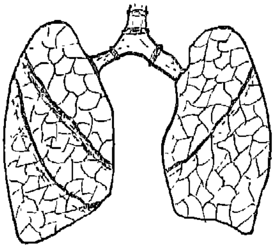

FIG 37
Sketch of the lungs to show the lobes of both.

Taken together with the heart, the lungs occupy the complete cavity of the thorax, and press against its walls at every point. What forms the anterior, posterior, and lateral confines of this cavity? Its shape is conical, the apex being

roofed in by the neck structure and the base formed by the diaphragm, which separates the thoracic from the abdominal cavity.

The mechanics of respiration. Students of physiology commonly get the erroneous idea that the lungs are muscular, and that inspiration and expiration are accomplished by them directly. Nothing could be further from the fact. The lungs are absolutely passive, and are possessed of no inherent neuro-muscular structure capable either of inflating or of deflating them. Thus, while respiration, and especially inspiration, is indubitably a muscular process, it is made possible by muscles located elsewhere than in or in attachment with the lungs themselves.

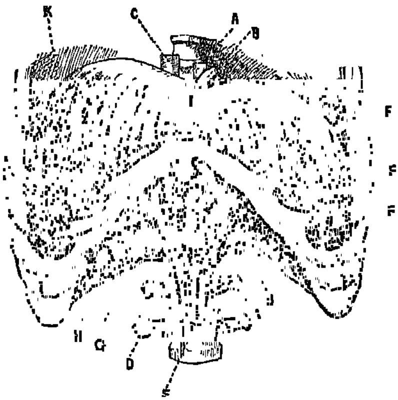

FIG. 38. THE DOME-SHAPED DIAPHRAGM

A, aorta; *B*, œsophagus; *C*, vena cava inferior; *D*, muscular pillars of the diaphragm arising from the spinal column *E*; *F*, ribs, and *G*, sternum, sawed through so as to allow removal of the front of the thorax; *H*, hind, and *K*, front, muscular sheet, and *I*, central tendinous part of diaphragm. (From Coleman's *Elements of Physiology*. By permission of The Macmillan Company, publishers.)

The inspiratory muscles, so-called, comprise the diaphragm and the intercostal muscles. The first of these, the diaphragm, forms, as we saw, the dividing structure between the thoracic and the abdominal cavity; it is the broadest muscle in the body, stretching completely across the lower thorax. It is attached laterally to the lowest ribs, and posteriorly to the spinal vertebræ in the lumbar region. In shape, the diaphragm resembles somewhat a large, rather shallow bowl

turned bottom up. The muscle fibers comprising the bulk emerge from the central, tendinous portion of the interior of the bowl, and these pass downward and attach themselves to the inner side of the lower ribs. Figure 39 indicates the appearance of the diaphragm and shows the attachment of the muscles.

The nerves which innervate the diaphragm are controlled by ganglia in the medulla oblongata; that is to say, the nerve impulses that control the action of the diaphragm are discharged automatically into it, requiring no volitional inception. This nervous discharge causes the muscular pillars connecting the dome of the bowl with the lower ribs to contract and pull down the bowl until it practically flattens it out. This downward sweep of the diaphragm operates to push downward and outward the stomach, intestines, and other organs of the upper abdomen, these not being confined anteriorly by bony structures of any sort. Thus the thoracic cavity is lengthened in inhalation, and the abdominal cavity shortened vertically and expanded in its anterior-posterior diameter.

When the thoracic cavity is thus lengthened by the descent of the diaphragm, the air in the lungs expands to fill the larger space. This expanded air is less dense than the air under atmospheric pressure outside the body; consequently the latter rushes in and equalizes with its own the density of the internal air. From this it will be apparent that the process of inspiration under ordinary conditions does not consist in the active and direct drawing-in of air, as is so commonly supposed, but rather in the elongating of the thorax and the consequent passive rushing-in of the air.

But in addition to providing a larger space for the expansion of the lungs by lengthening the thorax, Nature has also a means of increasing its diameter by lifting its side and front walls by means of the action of inter-costal and other

muscles. The inter-costal muscles, as their name indicates, lie between the ribs. Nature's mechanics in this connection are exceedingly interesting. As the diagram in Figure 39 shows, at the moment when inspiration starts, the ribs are slanted downward at a distinct angle; at the moment when the inspiratory process ceases the ribs are observed to occupy a much more nearly horizontal position. In fact, so much has been the upward movement at the anterior end of the ribs that each one of them has been raised to the approximate position occupied when inspiration started by the next rib above. This means in effect, since in general the diameter of the chest at each rib is greater than that at the rib next above it, that the gross expanse of the chest is greater after inhalation than after exhalation. In addition to this, the anterior-posterior diameter of the chest is increased also during inspiration by the fact that, since the ribs themselves are practically inflexible, the ascent of their anterior ends operates to push the sternum outward as well as upward. Thus does Nature provide for elongation, expansion, and deepening of the thoracic cavity during inspiration by the action of the inter-costal and other muscles of the thorax,

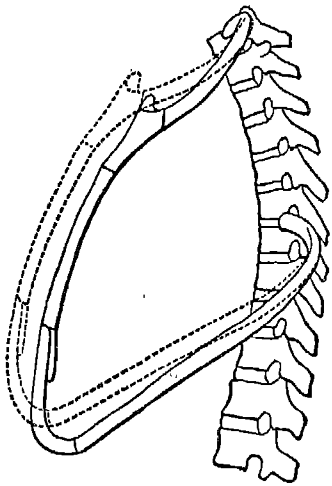

FIG. 39

Diagram of first and seventh ribs, in connection with the spine and the sternum, showing how in inspiration the latter is carried upwards and forwards. The expiratory position is indicated by continuous lines, the inspiratory by broken lines. (From Coleman's *Elements of Physiology*. By permission of The Macmillan Company, publishers.)

notably those extending downward from the shoulders and attaching to the outer surfaces of the ribs. These last mentioned are auxiliary inspiratory muscles, and are used chiefly in heavy or forced breathing.

The moment the nervous discharge into the inspiratory muscles ceases the process of expiration sets in. In ordinary, quiet expiration there is no muscular effort whatever, the retractility of the lungs, the weight of the chest wall, and the elasticity of the muscular walls of the abdomen all operating together to contract the thorax to its pre-inspirational dimensions, and so force the inspired air out by their pressure. Inspiration is, in other words, a purely muscular process, while expiration is a purely automatic and mechanical rebound. In forced breathing, the expiratory process may be aided by the muscles in the abdominal wall, and by certain others that reach up from the structures in the pelvic region and attach to the ribs from beneath.

2. *The hygiene of respiration*

The air we breathe. Fifteen times every minute, or thereabouts, we inhale five hundred cubic centimeters of air. The problem of guaranteeing that the tremendous volume of air breathed in by everybody, under all conditions and in all seasons and places, shall be reasonably pure and fresh is a problem that has baffled ventilating engineers for a generation, and is not yet solved satisfactorily. In connection with this question of fresh-air supply and its importance, there has always been a great deal of haziness and even of misinformation in the mind of the layman. He knows that the air in a crowded room in summer becomes shortly unbearable and induces fainting readily. He knows that drowsiness and headache are commonly experienced in a warm stuffy room in which the windows are closed. He

knows, by hearsay at least, that persons who are careless and indifferent about the ventilation of their homes, and especially their bedrooms, are more susceptible to colds and other respiratory diseases than are those who are particular in this matter. He knows that the air in an unventilated room when he enters it from the fresh out-of-doors may be almost nauseating in its foulness. He knows that the air in certain low-lying, marshy regions is reputed to be very unhealthy by reason of the 'miasmas' with which it is supposed to be permeated. But as to the truth of many of these hearsay contentions, and as to the real reasons back of conditions which he has himself observed, the average person is quite likely to be completely in the dark.

Exploded theories of ventilation. One of the most common pieces of positive misinformation met with is the conviction that the carbon-dioxide content in expired air may be quickly raised to the point where it becomes poisonous, and that this fact accounts as well for the drowsiness and lassitude experienced in an ill-ventilated room as for the occasional fainting attacks that occur in crowded assemblies. It is true, of course, that the metabolic processes going on continuously in the body release a considerable amount of carbon dioxide about — .6 cubic foot hourly — and that this gas is exhaled from the body as rapidly as it is formed. Theoretically it would seem logical to suppose that in an assembly where there were forty pairs of lungs contributing carbon dioxide to the common air, the volume of this poisonous gas might in a very few minutes rise to the danger point and result, if long continued, in asphyxiating the entire company. As a matter of experimental fact, however, it would require ten times as much carbon-dioxide content in the air as is ever found in the worst ventilated buildings to do any observable harm to the individuals breathing it, or to have any immediate appreciable effect upon them. Apparently

the reason for the deleterious effects known to be produced by poor ventilation upon human beings must be sought in some other factor than the alleged but disproved dangerous increase in the carbon-dioxide content of vitiated air. Dr. Kerr dismisses [1] the subject with these words: "The chemical composition of the atmosphere within any likely variations of respiratory impurity does not matter, and may be neglected in questions of ventilation." According to this old and now exploded carbon-dioxide theory the problem of ventilation could be solved by the introduction of any system which would remove from the air in a room the carbon dioxide contributed to it by the lungs of the occupants.

An interesting and striking proof of the fact that a relatively high carbon-dioxide content of the air is not harmful to the organism is seen in the fact that the alveolar cells in the lungs are bathed continually in air that is much more impure than that which is being breathed in at the moment. In our normal breathing approximately 500 cubic centimeters of air are inhaled and exhaled with each breath; this is known as the *tidal* air. With extreme effort, as when one is engaged in vigorous muscular exercise, 1500 cubic centimeters may be exhaled in addition to the tidal air; this is known as the *reserve* air. But deeper than this in the lungs are 1500 cubic centimeters more: the *residual* air, which cannot be voluntarily exhaled with the most violent effort. This residual air remains stationary in the depth of the lobules against the air cells, and it is from this that the blood absorbs its supply of oxygen and to this that it returns its carbon dioxide. In consequence, the residual air is highly impure, being always low in its oxygen content and high in its CO_2 content. From this physiological fact we can appreciate the fallacy of a few moments of 'breathing exercises' as a means of 'changing the air in the lungs.' The only

[1] In *School Hygiene* (English), August, 1915.

possible way of maintaining the residual air tolerably pure is to be always careful that we are breathing as clean air as possible, and to lead lives filled as far as possible with physical activity in order at least to compel frequent exchange of the reserve air and so keep the residual reasonably purified.

Another of the older notions of vitiated air may be termed the 'anthropotoxin' theory. According to this belief, which flourished quite generally a generation ago, certain albuminous substances — the products of metabolic processes — emanate from the body, and these are responsible for the stuffy, unpleasant odors found in poorly ventilated rooms. Not only did these "anthropotoxins" possess a disagreeable odor, but they were believed also to be poisonous, as their name would indicate, when breathed into the lungs. Such epithets as "crowd poisons," "breath poisons," "organic poisons," and the like, were variously applied to these effluvia. The chief source of these substances was thought to be the products of albuminous decomposition from intestinal, dental, nasal, and cutaneous surfaces. While it may be true that certain of the products of katabolism which emanate from the body contain poisons in minute quantities, careful experimental procedure has failed completely to demonstrate that the effects of these are or can be under any ordinary circumstances physiologically deleterious. Adherents to this theory obviously considered ventilation to be a problem of continuously changing the air in a room in order that the accumulation of these toxic elements might be prevented.

Experiments of Paul and Hill. For some years there have been glimmerings in the experimental work that the real problem of ventilation is not internal, but external, to the body. Especially noteworthy in this connection, and serving finally to establish the now accepted tri-partite

theory of ventilation, were the experiments made by Paul and Flügge,[1] in the latter's laboratory at Breslau. A glass cabinet, specially constructed and large enough to enclose a man and a few simple instruments within it, was used in these notable experiments. Paul shut himself within the cabinet and proceeded to breathe the same unventilated air over and over until it contained far more carbon dioxide than would ever be found in the worst ventilated schoolroom, theater, or other place of assembly. He found that as soon as the heat and moisture from his body had combined to raise the temperature in the cabinet above 68° F., and the humidity to 70 per cent, or more, he began within a very few minutes to experience the most disagreeable and serious symptoms, including headache, vertigo, and nausea, and he was upon the verge of fainting.

As soon as the air within the cabinet became unbearable for these reasons, and he felt in imminent danger of collapse, Paul started a small electric fan, with which his cage was equipped. Forthwith, as the fanning cooled and dried the air, restoring the temperature to 68° F., and the humidity to sixty per cent or thereabouts, he began to feel relief, shortly recovered completely, and was able to remain for over four hours in the cabinet without experiencing any further disagreeable symptoms. Ventilation appeared, from this initial experiment of Paul, to be a matter of keeping the entire body surface cool and its moisture evaporated by the maintenance of a reasonably low temperature and humidity.

In subsequent experiments with the cabinet, Paul was able to demonstrate still more conclusively the falsity of the alleged deleterious effects of carbon-dioxide excesses, and more firmly to establish the importance of complete body-surface aëration as the prime problem of ventilation. Allow-

[1] For an account of this experiment in English, see W. P. Northrup's article in the *Pedagogical Seminary*, 1909, vol. VII, p. 442 ff.

ing the temperature within the cabinet on one occasion to climb again to 70° F., with a corresponding rise in humidity, Paul put his head outside the cabinet into the pure air without, leaving his body still enclosed in the cabinet. Absolutely no relief was experienced by this procedure; he continued to suffer from faintness and vertigo. Again, on another occasion, he stood outside the cabinet, with his head inside, and breathed the vitiated air within for a considerable period, but was wholly unable to produce any of the disagreeable symptoms.

Hill, another experimenter, working with a similar type of cabinet, verified and extended[1] the findings of the German investigator. He was able to keep his subjects comfortable in the cabinets even up to the point where the carbon-dioxide content was twenty times as high as is ever found in the most wretchedly ventilated rooms, and where the oxygen content was so diminished that ordinary candles would not burn, and cigarettes could not be lighted. By the use of an electric stove to heat the air and fans to cool it, he was able to control the temperature in his cabinets, *ad lib.*, and so demonstrate the truth of the theory of Paul. In another experiment, Hill kept guinea pigs for as long as three and a half months in air-tight cages, without causing any physiological disturbance. In fact, as long as he kept their cages cool and dry they throve in spite of the 'badness' of the air.

The modern accepted theory of ventilation. Upon these and other experiments, the modern theory of ventilation has been builded. Fundamentally it considers that both for comfort and for the preservation of life itself it is essential that the superfluous heat be liberated from the body under any and all conditions. Ventilation becomes, therefore, not

[1] "Stuffy Rooms," by Leonard Hill, in *Popular Science Monthly*, 1912, pp. 374–96.

a matter of reducing the carbon-dioxide content of the air, nor of exhausting from a room the organic anthropotoxins discharged into it from the bodies of its occupants, but rather a matter of providing for the elimination of the superfluous body heat.

Perhaps the best practical illustration of the essential problem of body ventilation is to be found in the physiological reactions of the body on a sultry day. As every one knows, when the temperature is high and the air is nearly saturated with moisture, and when there is no air in motion, people are overcome with heat in considerable numbers, and to be alive is almost a burden to any one. As I sit writing this paragraph, for example, the August air is very oppressive; a dozen times earlier in the day I have thrown down my pen and sought some measure of relief in complete relaxation. The thermometer reads 92° F., the air is peculiarly muggy, and the leaves on the trees are not stirring. In the distance faint rumblings of the approaching thunderstorm which will bring relief are already to be heard. Perspiration stands unevaporated on my face, although I am physically inactive. Notwithstanding the lesser amount of carbon dioxide in my study than was to be found in the cabinets of Paul and Hill, the two sorts of environment are identical, and the storm gale will bring me in a few minutes precisely the same relief that the electric fan brought to those experimenters, and for practically the same reason. My body, like theirs, is encased in a 'steam jacket' which only a cool, dry breeze can penetrate and dissipate.

There are three essentials in a well-ventilated room. In the first place, the temperature must be low — not over 65° F. except in coldest weather, when 68° F. may be permitted; the humidity must be low — not much above 60 per cent; and the air must be kept in constant though not necessarily perceptible motion. Given these three conditions, workers

at any indoor task — in schoolrooms or elsewhere — perform efficiently and with the minimum of restlessness and fatigue. The problem of the ventilating engineer, according to the modern accepted theory, is, then, quite regardless of its chemical constituency, to keep the air in a building cool, dry, and in circulation. Such is the air out-of-doors when it is most comfortable: such must be indoor air if the organism is to thrive. Incidentally, of course, while not aiming primarily to keep the carbon-dioxide content low, engineers who provide the three essentials mentioned above in the air of their buildings will be also ordinarily supplying air comparable in composition to the air of the out-of-doors.

Badly ventilated schoolrooms. We take pains to provide every possible right condition for the educative process. We have fine, comfortable buildings, adjustable furniture, elaborate pedagogic equipment, skilled teachers, and competent superintendents. But we do not yet have very many well-ventilated schoolrooms, partly because teachers have not themselves understood the importance of the matter; partly because school architects and ventilating engineers have been unable to supply us with any wholly adequate systems of ventilation. And yet there is perhaps no more vital factor in the whole educational environment than this.

A considerable number of exceedingly interesting studies have been made of the effect of various temperatures upon the efficiency of school work. We shall refer to but two of them at this point. Superintendent Hines reports [1] that in a room where the temperature was 80°, the class was restless, dull, and incapable of continued mental effort. At 76°, the class was sleepy, and the penmanship was poor; at 75°, the class was dull and complained of the heat; at 74°, they were only slightly less dull; at 72°, they were restless;

[1] Hines, L. N: "The Effect of Schoolroom Temperature on the Work of Pupils," in the *Psychological Clinic*, 1909, vol. III, pp. 106–13.

at 70°, they did excellent work, and there was a general atmosphere of cheerfulness in the class; at 68°, they were doing their best work; at 66°, their work was still splendid; at 65°, they were happy and industrious, although some were inclined to complain at the coldness of the room; at 60°, they were too cold for good work and complained of the cold.

Dexter has studied[1] the relationship between conduct and room temperature by an analysis of the number of bad marks given in schools of New York City. The recorded temperatures of the different rooms studied varied between 60° and 80° F. "The rooms with temperatures below 68° F. had fewer misdemeanors than the normal, hence may be interpreted as quieting in effect; those from 69° to 73° F. showed about the normal; while the highest temperatures recorded were accompanied by deficiency of disorder, twenty per cent less than the normal being recorded for a schoolroom temperature of 79° F. This decrease in active disorder for conditions of most excessive heat was shown to a marked degree in a study of assault, suicide, and discipline made in the penitentiary in a manner similar to this, and without question is but a result of the physical lassitude which every one feels under such temperature, and is chronic with the inhabitants of the torrid zone."

From these and other studies, it appears that not only can the most effective work be done in a moderate temperature, but misdemeanors are less likely to multiply in it than they are if it is allowed to rise above 68°. There is little doubt, however, that most of our schoolrooms are distinctly overheated during the cool part of the year. Burnham says,[2] in this connection:

[1] Dexter, E. G.: *Weather Influences.* The Macmillan Co., New York. 1904. 286 pp.

[2] Burnham, W. H: "The Optimum Temperature for Mental Work"; in the *Pedagogical Seminary*, 1917, vol. xxv, pp. 53–71.

What is needed is not better discipline or more efficient methods, but chiefly a mere reduction of the schoolroom temperature. The condition of the ordinary schoolroom in this part of the country (East) as regards temperature, not to mention minor matters such as school dust, bad odors, and the like, is often unpardonable. The one reform which perhaps more than any other is obviously needed in our schoolrooms is a lower temperature. And when we reflect that decreasing the heat would not only increase the efficiency of the school work but decrease the money paid by the taxpayers, the question why this reform is not brought about remains one of the puzzles of school hygiene, and can be accounted for psychologically only on the basis of the force of custom and the power of the law of inertia.

Methods of ventilation. There are three main methods of ventilating schoolrooms in use, as follows:

1. *The natural method.* The earliest method of admitting fresh air to a room, and the one still commonly in use in our homes, was by means of open windows and doors. This is often designated as the 'natural' method of ventilation. Rooms aired in this way are almost certain to be uncomfortable. In warm weather, unless there is a breeze blowing to move in the outer air through the windows, the air inside the room may remain stagnant and oppressive in spite of the open windows. In cold weather, the change in temperature which comes when the windows are thrown open is usually too abrupt, those who sit near them are subjected to drafts, and the bother of continually raising, lowering, or setting them is considerable. The natural method is reasonably satisfactory in fall and spring, but very highly unsatisfactory in winter. Where school houses are ventilated by this means, it is important that teachers shall take particular care so to operate the windows that the very best possible results from their use may be attained. In this connection it is important to understand that they should be opened both at the top and at the bottom — slightly, of course, in

extreme weather — rather than at the bottom only, and that as far as possible they should be open continuously, even if the opening be but a half-inch or so. Most janitors are inclined to look somewhat askance upon an open window in January: they are likely to be somewhat old-fashioned in their ideas, and to consider ventilation an unimportant detail. Many of them are convinced that if they can but keep the mercury around 75° F. on a cold day, everybody will be comfortable and the school routine will pass off smoothly.

2. *The gravity method.* A second method of ventilation commonly found in the older school buildings is the so-called 'gravity' system. The chief point of difference between this and the natural method, above described, lies in the fact that in the gravity system the air is introduced into the room from the outside and returned again to the outside through an inlet and an outlet duct, respectively. Passing up between the outer and the inner walls or in a special shaft, the inlet duct enters the room at a point about two thirds up the wall. Its orifice is usually screened, and the volume of air admitted may be controlled by a shutter. The lower end of the inlet duct

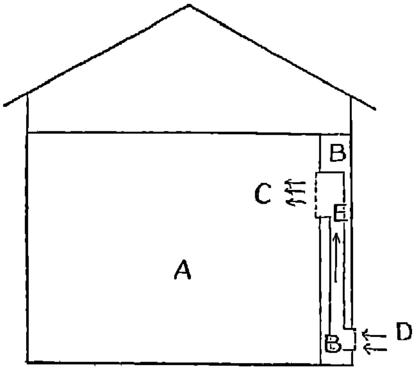

FIG. 40

Sketch to illustrate the salient features of the inlet duct in a gravity system of ventilation. The arrows indicate the direction of the movement of air currents. *A*, schoolroom; *B*, space between the walls of the building; *C*, opening of the duct in the side wall near the ceiling; *D*, opening of the duct in the outer wall near the ground; *E*, the inlet duct.

passes through the outer wall at a point near the ground, the opening being carefully screened to prevent dust from blowing in. Figure 40 shows the appearance of an inlet duct in a gravity system of ventilation. The outer air, when there is any breeze, or when it is colder than the air within doors, readily passes into the duct and is delivered to the rooms of a building through the several flues. There is often a warming chamber, kept at a moderate temperature by the furnace, through which the air in the inlet duct is passed before it is delivered to the rooms.

The chief objection to the gravity system is, as is true in the case of the natural method, that when the weather is warm, or the air is still, it does not ventilate because there is nothing to move the outside air through the duct and into the building.

In addition to the inlet duct, the gravity system has also an outlet duct. The opening of this flue is usually just beneath the orifice of the inlet duct, and as close to the floor as possible. Passing upward between the walls, or within its special shaft, the outlet duct terminates in some form of orifice on the roof. It exhausts on the same principle as a fireplace or a chimney; the air passing over it tends to create a suction

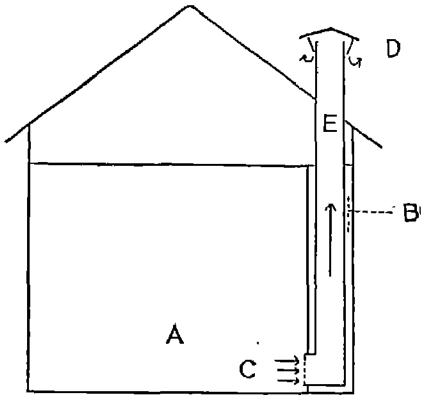

FIG. 41

Sketch to illustrate the salient features of the outlet duct in a gravity system of ventilation. *A*, schoolroom; *B*, space between the walls of the building; *C*, opening of the outlet duct near the floor of the room; *D*, terminus of the duct on the roof of the building; *E*, the outlet duct.

which draws out the air from the rooms communicating with the shaft. When there is no air moving, however, the amount of exhaustion is slight.

In the gravity system of ventilation, then, we have—theoretically at least—an inlet duct to pass the air into the room and an outlet duct to remove it after it has been circulated across the room or rooms and drawn into the flue. Most of the older and many of the newer school buildings are ventilated by this method, in combination with the natural method; its frequent unsatisfactoriness has already been indicated.

3. *The mechanical method.* The third method of ventilation is known as the 'mechanical' method. This method proposes to insure a continuous volume of air in all seasons and weathers, commensurate with the needs, by means of electric fans operating in the ventilating shafts. In the *plenum* mechanical system, a fan is placed in the inlet duct, with its blades so pointed as to draw air inward into the building at a known rate. The inlet duct itself does not differ essentially from that found in the gravity system, and the air passing inward may likewise be heated in a warming chamber. In the *vacuum* mechanical system, the fan is placed in the outlet duct, and its blades pointed so as to draw the air out of the room and drive it up the shaft to the roof.

Some buildings have only the plenum fan; some have only the exhaust fan; some have both. The fans are supposed to be kept carefully regulated, so that a continuous flow of air, without perceptible draft, passes into, through, and out of the room at all hours and in all seasons. Theoretically, this sounds ideal. In operation, however, the mechanical systems still leave much to be desired. As a rule, the heated air delivered by the plenum method is altogether too warm for schoolroom efficiency, so that for real ventilating purposes the air is nearly destroyed before it is introduced into the rooms. The plenum system is also unsatisfactory be-

cause of its mechanical rigidity, which requires doors and windows to be kept closed in order not to interfere with its operation. Slight variations in temperature, which appear to be essential for the body, are not provided for by such a system of ventilation. The fan has a heavy 'load,' and is likely to be noisy and vibratory. Dust is deposited by the warm air on every cool surface it meets, imparting to the room a dirty appearance, which is a source of much complaint. Dryness of the throat is frequently noticed in a mechanically ventilated room. It has been pointed out by some observers that if both plenum and exhaust fans are employed, one on one side of the room and the other on the opposite side, thus keeping the air about the atmospheric pressure; and that if the air delivered is from 10° to 15° below the room temperature, and properly filtered and humidified, satisfactory results may be attained. Several small fans are considered better than a single large one.

Type of ventilation and pupil health. Reference was made in the preceding paragraph to the excessive drying effect which the superheated air delivered by the plenum system has upon the mucous membranes of the throat and nasal passages. In this connection a very illuminating experiment was carried on in New York City, in 1916–17, by the Bureau of Child Hygiene of the Department of Health, to determine if possible what was the relationship between the health of the pupils and the type of ventilation used in the schoolrooms. Altogether an aggregate of 5533 children in 134 rooms were included in the studies made. All other conditions were carefully controlled, so that the results might be as scientifically accurate as possible.[1] Three types of ventilation were included in the experiment, as follows:

Type A. These were the so-called cold, open-window classrooms, ventilated by natural means. It was desirable to have the tem-

[1] *American Journal of Public Health,* January, 1918.

perature kept at 50° F. This, however, was found to be impossible owing to variations in the weather, and it therefore ranged from 50° to 60°, and sometimes higher.

Type B. These were moderate-temperature classes, kept between 60° and 70° F., averaging about 68° F. Ventilation was wholly by open windows. Some had gravity exhaust ducts, while others did not. Window deflectors were used in only one room in the 1916 study, while in the 1916–17 study, window deflectors were installed and used in all rooms.

Type C. These rooms were of the same moderate temperature as Type B, averaging 68° F. Ventilation of the classrooms was by the plenum fan system installed in the buildings, the windows in these classrooms being kept closed.

The experiments were conducted by the physicians and nurses, and extended over a period of five months. The most surprising things found were, first, that in the mechanically ventilated classrooms (Type C) there were 32 and 40 per cent more absences from respiratory diseases than from Type B and Type A classrooms, respectively; and second, that in these same mechanically ventilated classrooms 98 and 70 per cent more children suffered from respiratory diseases, while continuing in their regular attendance, than were attacked in the Type B and Type A classrooms, respectively. In other words, if the New York City results are found to be typical of conditions in the country at large, it appears that mechanical systems of ventilation predispose to respiratory disease from approximately 33⅓ to 100 per cent more than does the older method of window ventilation. In the face of this experiment, proponents of plenum and vacuum systems would seem yet to have to demonstrate the wisdom of mechanical ventilation for school buildings. And yet many of the newer buildings are being equipped with fans, humidifiers, and air-washing outfits, in the belief that they represent the last word in the ventilation of large buildings filled with children during five or six hours of the day.

Other experimental data must be awaited before we can pass final judgment upon the mechanical as compared with any other system of ventilation. In the meantime, teachers may themselves help out matters very much by insisting that their janitors keep the temperature moderately low — never over 68° F. — and by preventing excessive dryness of the air in the room through wise use of windows, through plenty of green potted plants about the room, and through basins of water kept around the radiators. Until the experimental evidence is stronger than at present, they may still hope to provide reasonably good ventilation during most of the days in the school year by means of the windows.

Hygienic breathing. A few words as to proper breathing may advantageously be added here.

1. *Full breathing.* In the interest of health, as well as of comfort, any article of clothing that is binding enough to cause appreciable pressure or tension during inspiration is harmful. There are three distinct types of breathing: abdominal, chest, and full or natural. In the last type, because there is no constricting agent at the belt, chest, or abdomen, the diaphragm meets with the minimum of opposition as it descends during inhalation. The abdominal organs are moved downward easily and without friction, while the ribs move upward and outward without restriction, heightening and deepening the chest as nature intended. If you note the heavy breathing or panting of a dog or horse immediately after brisk exercise, you will be struck with the completeness, the 'fullness' of the expansion of the whole respiratory region. Or if you will but observe your own unhampered breathing after gymnastic exercise, you will find the same thing to be true. Complete breathing necessitates freedom of respiratory movement along the entire chest and abdomen. In the so-called chest breathing, owing to the presence of confining clothes about the lower

waist and abdomen, the upward movement of the chest is exaggerated. The diaphragm in its descent meets with resistance, and the lungs are forced to expand abnormally in their upper lobes. Women who lace tightly are usually chest breathers by force of necessity. They seek a 'good figure' at the expense of comfort and of health, for continuous chest breathing is very exhausting, and constriction of the abdominal organs by a tight corset greatly impedes the vital physiological processes going on within them. It is interesting in this connection to note that men, Indian women, and civilized women who have never worn a corset are invariably non-chest breathers.

In abdominal breathing, there is practically no expansion of the lungs in their upper lobes and apices. Room is made for the volume of in-coming air during inspiration by an exaggerated descent of the diaphragm and a corresponding pushing out of the abdomen. Abdominal breathing is commonly due to poor postural habits, and is found usually in individuals who have a tendency to kyphosis. The shoulders droop forward depressing the shoulder girdle and the sternum, so that the upper thorax cannot be lifted easily by the inter-costal and other muscles. The heart and lungs are crowded in consequence, and breathing becomes necessarily abdominal, or diaphragmatic. Gradually the abdominal organs lose their resiliency, and the diaphragmatic breather very soon presents a disagreeably round and protruding abdomen and a sunken chest — both of which are in striking contrast with the flat abdomen and high chest which give poise and gracefulness to the body of the full breather.

2. *Nasal breathing*. There are at least three important hygienic reasons for breathing through the nose rather than through the mouth. In the first place, as we have seen, the membrane lining the nostrils is supplied with ciliæ which

project into the cavities, and operate, by means of their continuous wave-like motions, to remove dust and microbes from the air as it is inspired and push them into the pharynx, whence they are expelled. Air breathed in through the mouth is not thus strained, and there is more possibility of dust particles and germs of disease reaching the deeper respiratory tract and causing trouble. Second, the nasal membranes are richly supplied with blood vessels, as we have also seen, and these serve as warming radiators to raise the temperature of the air nearly to that of the body as it is drawn over them. In cold weather these vessels are dilated to receive a greater volume of blood; thus, no matter how low the temperature of the air outside, it is warmed before it reaches the bronchi. Air inhaled directly through the mouth is not thus warmed, and there is danger that the lower respiratory passages may be chilled in cold weather. And finally, the glands in the nasal membranes serve as ideal humidifiers of air inspired through the nose, approximately one pint of water being contributed to the inspired air in the course of twenty-four hours. However dry the air may be, within reasonable limits, these 'nasal humidifiers' are capable of raising its relative humidity to 60 per cent or more, and so supply to it a quality which is indispensable for the easy interchange of gases at the pulmonary capillaries. Air breathed through the mouth very soon results in drying out the oral and pharyngeal membranes, and is introduced into the lungs too dry for easy interchange.

In addition to these major physiological reasons for nasal breathing, in preference to oral breathing, at least two other minor reasons may be given. First, the habitual mouth-breather is in grave danger of losing his sense of smell. Only constant breathing through the nose will preserve the sensitivity of the olfactory end-organ to dangerous as well as

disagreeable odors. Second, the resonance chambers in the nasal cavities impart to the voice a characteristic quality, or timbre, which is essential in pleasing phonation. If the nostrils are obstructed so that these chambers can no longer deepen and enrich the spoken word as it reverberates through them, an irreparable loss has been sustained. For all these and other lesser reasons, it is important in the hygiene of respiration that the nasal passages be kept open, and that they be made habitual use of in our breathing.

TEACHING POINTS IN THIS LESSON

A. Structure and Function

1. The air route to the alveoli.
2. The olfactory end-organ.
3. The vocal cords and the voice.
4. The internal structure of a lung.
5. The interchange of oxygen and carbon dioxide in the lungs.
6. The mechanics of respiration.

B. Hygiene

1. The 'carbon dioxide' theory of ventilation.
2. The 'anthropotoxin' theory of ventilation.
3. The Paul-Hill experiments.
4. The modern theory of ventilation.
5. The natural and gravity methods of ventilation.
6. The plenum and vacuum systems of ventilation.
7. Natural, or full, breathing.
8. Chest and abdominal breathing.
9. Nasal *versus* mouth breathing.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Look up and study the respiratory apparatus of fishes.
2. Write out in your own words a description of the mechanical processes involved in the complete respiratory act.
3. Make an investigative tour of your own school buildings for the purpose of determining the types and efficiency of the ventilating systems used. If the gravity system is used, locate the main inlet duct or ducts in the outer wall, the warming chamber, the branch ducts opening into the several rooms, the outlet ducts and the orifices. If a

mechanical system of ventilation is in operation, locate the fans and study their working.

4. Prepare a "temperature chart" for the various classrooms and the assembly hall of your school, and enter upon it daily in the middle of the forenoon and of the afternoon the temperature of each room. Continue this over a period of a week. Summarize your conclusions concerning the ventilating efficiency of the system in use in so far as the room temperature is an indication of it. If your science department possesses a hygrometer, humidity readings in the several rooms may also be taken by one member of the class during the week at the same hours. Paper streamers suspended carefully in the rooms near the inlet ducts will indicate whether there is any air movement.
5. Study your own respiratory habits with the view of determining whether you are a chest, abdominal, or natural breather. If you conclude that you tend toward either of the two first types, it should be the part of wisdom for you to make the proper alterations in clothing or in postural habits that will free the thorax from pressure and permit it to expand throughout its entire depth.
6. Enumerate as many reasons as you can find for people breathing through the mouth instead of through the nose.

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1. Burton-Opitz, R. *An Elementary Manual of Physiology*, chaps. 17, 18, 19, 20.
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3. Pyle, W. L. *A Manual of Personal Hygiene*, pp. 94–124.
4. Terman, L. M. *The Hygiene of the School Child*, chap. 10.
5. Williams, J. F. *Personal Hygiene Applied*, chap. 8.

CHAPTER VIII

THE LIFE STREAM: CIRCULATION

1. *Structural approach*

The vital processes of the organism. In a very real sense every process that takes place within the body is a 'vital process.' Physiologists commonly include within the meaning of this expression, however, only the two major vital processes of respiration and circulation. Having studied the former of these in the preceding chapter, it is proper and logical for us to devote the present chapter to a study of the latter process: the circulation of the blood. As we have already seen, the end of the respiratory process is to contribute oxygen to the blood at the pulmonary capillaries and to remove carbon dioxide from it. We are now to trace the subsequent story of the molecules of oxygen after they have entered the blood, the chemical changes which occur within the blood, its route through the body, and such other facts of structure and function as need to be understood by the student and teacher of hygiene.

The composition of the blood. There are three main elements in the blood, as follows:

1. *The red corpuscles.* If we were to examine a drop of blood under the microscope, we should find that it is not a red fluid of even constituency, but that it is made up of a straw-colored fluid, called *plasma,* in which are seen to be floating large numbers of conspicuous red corpuscles and a smaller number of white corpuscles. The red corpuscles, being so numerous and possessing such striking pigments, give the common illusion that the blood is an undifferentiated red fluid.

Under the microscope the red corpuscles, called *erythrocytes*, appear as circular discs, having a diameter of one thirty-two hundredth of an inch and a thickness not in excess of one fourth of the diameter. In cross-section, a red corpuscle is seen to be a trifle thicker at its marginal than in its central area, as indicated in Figure 42. The blood of a human being contains, by count, approximately 5,000,000 red corpuscles per cubic millimeter of blood, or a total of some 20 trillions in an adult of medium size. As we have seen in a previous lesson (see Chapter VI), these corpuscles are manufactured in the red marrow of the bony structures. Since they are being constantly worn out and destroyed by their activity in the organism, it is evident that the production of new corpuscles in the red marrow must be uninterrupted if the health and vigor of the body are to be maintained.

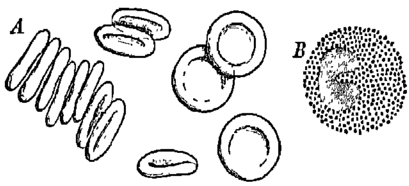

FIG. 42. BLOOD CORPUSCLES (*greatly magnified*)
A, red blood cells; *B*, a white blood cell.

In the interior of the red corpuscle there is contained a substance known as *hæmoglobin* which possesses the chemical property of uniting with the oxygen brought into the capillaries in the lungs in the inspired atmospheric air. For this reason the red corpuscles are often spoken of as the oxygen-carriers of the blood. When thus freely charged with the gas, the hæmoglobin is termed *oxyhæmoglobin;* this imparts to the blood a peculiarly bright reddish color, for which reason oxygenated blood appears much redder than bluish, de-oxygenated blood, some of which may be seen in the veins near the surface of the body. The rôle played by the red corpuscles in the blood stream is an extremely im-

portant one, for it is they which contribute to the cells of the body tissues the oxygen needed by them to consume the nutritive substances and so maintain the process of metabolism. Only through this uniting of oxygen with the food particles absorbed by the cells can oxidation take place, and in a real sense life is oxidation. When there is a radical reduction in the number of red corpuscles in the blood, due to a considerable number of possible causes, there develops a condition known as *anœmia*.

2. *The white corpuscles.* In much smaller numbers, floating in the blood stream, are the white corpuscles, called *leucocytes*, or *phagocytes*. These vary more widely in size than do the erythrocytes, the smallest ones being only half as large while the largest ones may be nearly twice as large. The leucocytes are amœboid in nature; that is to say, they possess the capacity of changing their shape by throwing out tiny processes, and of surrounding and engulfing foreign substances that may be in their pathway. As compared with the 5,000,000 red corpuscles, there are not more than 10,000 leucocytes to the cubic millimeter of blood. In addition to their amœboid quality, the leucocytes are able to attach themselves to the walls of the blood vessels, where they are ordinarily found in great numbers during conditions of health, and even to perforate and pass through them in order to reach neighboring tissues that may be attacked by bacteria. And this last, indeed, is the prime function of the leucocytes in the blood stream. They may be termed appropriately the health officers of the body, who are always on the watch for invading micro-organisms and who, having detected their presence by some marvelous chemical process, forthwith advance upon them and destroy them, giving often their own lives in the encounter.

In times of microbic disease these ready health officers are given right of way through the body, their progress being

facilitated by the blood vessels themselves, which relax along the invaded area and thus admit the phagocytes that collect in large numbers. From thence they penetrate in legions through the vascular walls and enter the infected tissues. There they surround and devour the microbes, many of the valiant defenders succumbing in the fray. The pus produced freely in such infections is made up largely of the dead bodies of the phagocytes which have given themselves unstintedly to check the inroads of the microbic intruders and are now exuded as pus. This process, known as *phagocytosis*, is the body's chief spontaneous means of self-defense against bacterial invasion. The numbers of white corpuscles in the blood stream in times of health are increased, and their potency strengthened by the ordinary hygienic measures, such as physical exercise, cold bathing, proper nutrition, etc., hence the important bearing of a hygienic regimen upon disease resistance.

3. *The plasma.* The yellowish fluid constituting the solvent element in the blood is called the *plasma*, and is almost as clear as water. The plasma serves to keep the blood in a liquid state so that its circulation may be made possible, and so that the contained corpuscles may be speeded on their vital missions without friction. The plasma also serves as a stream in which the nutritive elements extracted from the food in the intestinal tract may be floated to the inter-cellular spaces for absorption by the cells of the body; certain waste products of metabolism are also floated in the plasma to the excretory organs, notably to the kidneys.

The organs of circulation. There are four main organs that should be considered:

1. *The heart.* Suspended in almost the exact center of the thoracic cavity, and lying immediately behind the breast bone is the mammalian heart. Shaped somewhat like an

inverted cone, it is approximately the size of its owner's fist. The lower tip of the heart (the apex of the inverted cone) is turned somewhat to the left from the median line, and touches the left chest wall at a point in the region of the fifth and sixth ribs. It is at this point that its pulsation can be both heard and felt — a circumstance that has been responsible for the erroneous supposition in the minds of beginning students of anatomy that the heart lies on the left side of the body.

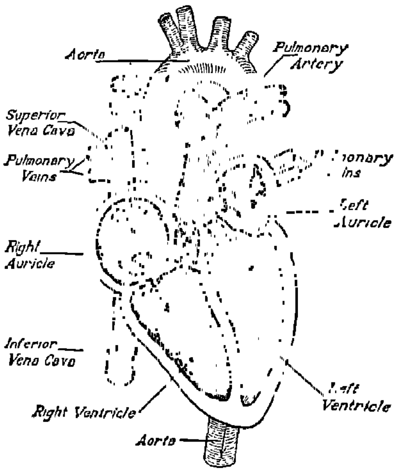

FIG. 43

Diagram to show the course of the blood through the heart. The vessels containing impure blood are drawn darker than the others. (From Williams's *Healthful Living*. By permission of The Macmillan Company, publishers.)

Structurally, the heart is comprised of four elastic chambers whose walls are formed of muscle tissue. The two upper chambers are called the *right auricle* and the *left auricle*. The lower chambers corresponding are called the *right ventricle* and the *left ventricle*, respectively. The two auricles serve as receiving chambers, or ante-chambers, the right auricle receiving the de-oxygenated blood from the veins, the left one receiving the oxygenated blood from the lungs. The two ventricles are the sending chambers, the right one sending the de-oxygenated blood outward to the lungs, the left one sending the oxygenated blood outward through the *aorta* to the body. There is no direct inter-

communication between the two auricles, and none between the two ventricles. The right auricle connects with the right ventricle, however, by means of a *tri-cuspid valve* which opens only ventricle-ward; and in a similar way the left auricle communicates with the left ventricle by means of a *bi-cuspid valve* which also opens only ventricle-ward.

Passing outward from the right ventricle to the lungs is the large pulmonary artery, through which the de-oxygenated blood in the right ventricle is pumped to the lungs; entrance to this from the ventricle is through a *semi-lunar valve,* which opens outward only. Similarly, passing outward from the left ventricle to the body proper is the *great aorta,* entrance to which from the ventricle is also through a semi-lunar valve which opens outward only. Entering the right auricle, bringing the de-oxygenated blood that has been collected from the various tissues of the body, are two large veins, the *upper* and *lower vena cavæ.* And similarly, entering the left auricle, bringing the oxygenated blood from the capillaries of the lungs are the *pulmonary veins.*

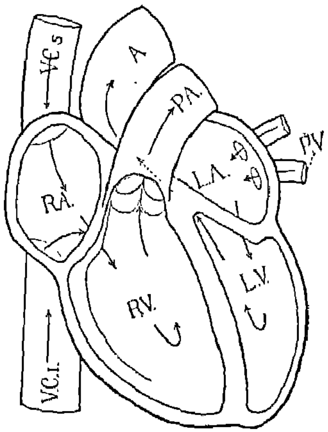

FIG. 44. THE BLOOD-ROUTE THROUGH THE HEART

RA, right auricle; *LA*, left auricle; *RV*, right ventricle; *LV*, left ventricle; *A*, aorta; *PA*, pulmonary artery; *PV*, pulmonary veins; *VCs*, vena cava superior; *VCi*, vena cava inferior. At the entrance to the pulmonary artery are shown two of the pockets of the valve, the third pocket having been cut away with the front side of the artery. The other blood tubes have similar valves, not shown in the diagram.

A complete circuit of the blood through the body would be as follows: entering the right auricle through the two vena cavæ, the blood is forced downward through the tri-

cuspid valve into the right ventricle, which is the pulsating chamber that sends the blood coursing out of the right side of the heart through a semi-lunar valve into the pulmonary artery. This vessel carries the blood to the capillaries of the lungs, where its carbon-dioxide content is exchanged for oxygen. From thence it is passed through the pulmonary veins to the left auricle, and from that chamber it is forced through the bi-cuspid (mitral) valve into the left ventricle. When this chamber pulsates it squeezes the blood out through a semi-lunar valve into the aorta, whence it is distributed through ever narrower and narrower arterioles to every part of the body, to be collected again in the venous vessels and returned to the right auricle of the heart.

The actual weight of the heart is some ten ounces. Some idea of the work which it performs in the course of twenty-four hours may be had by reflecting that it pumps a volume of blood equivalent to approximately ten tons in that time. This fact indicates also the supreme hygienic importance of keeping the circulatory system in first-rate condition and the general health high in order that the valves of the heart may not be scarred or weakened by disease toxins, and in order that the efficiency of the muscle-pump may not be impaired by overwork, strain, or lesions produced by drugs or toxins.

In action, the auricles pulsate simultaneously and the ventricles pulsate simultaneously, but the pulsation of the two auricles precedes that of the two ventricles by a tenth of a second. Thus, the complete cardiac cycle comprises, in the first place, the forcing of blood into the two auricles by dual auricular contraction, and in the second place, about a tenth of a second later, the forcing of blood into the two arteries (pulmonary and aorta) by dual ventricular contraction; the two beats, distinctly felt and heard, are followed by a perceptible period of rest about a half-second

in duration. In men there are approximately 70 pulsations per minute, while in women there are usually about 80, and in children commonly 90. This of course is true only when the body is at rest; under stress of muscular exertion the number of pulsations may be doubled. The contraction of the heart immediately before pulsation is known as *systole;* its dilation immediately subsequent to pulsation is known as *diastole*.

2. *The arteries*. The walls of the arteries are composed of three separate layers; the outer layer is made up of connective tissue; the middle, of involuntary muscle cells; and the inner, of smooth epithelium. The connective tissue, found in great abundance in the aorta and the larger arteries, imparts to these vessels an elasticity which is of the utmost importance in adapting them to the varying volume of the blood being transported through them. In the smaller arterioles the muscular cells are arranged circularly about the tubes, and by their contraction aid in lessening the volume of blood that can pass through. The arteries lie deeper in the body than the veins, and are consequently less likely to be severed through accident. They are always found carrying blood outward from the heart, either to the lungs for purification or to the body tissues for metabolic purposes. We may liken the aorta and all the smaller arteries and arterioles arising from it to a tree whose trunk represents the aorta, and whose branches represent the lesser vessels. The further away from the root and trunk we travel, the smaller grow the branches, until at the outermost extremities of the tree the tiny twigs are relatively very small indeed. If we reduce in imagination the size of the tree to the scale of the arterial system, we shall have a tolerably satisfactory model of the aorta and its branches throughout the body. Loss of elasticity in the larger arteries, due to heredity, predisposition, infection, tobacco, alcohol, lead, and other

poisons, or to continuous overwork of the tissues, leads to a condition known as *arterio-sclerosis*, or hardening of the arteries.

3. *The veins.* In comparison with the walls of the arteries, the walls of the veins are thin and soft. Owing to the fact that the blood found in the veins has been slowed down by passing through the capillaries, it is under relatively slight direct pressure from the heart, and moves forward only by virtue of the fact that the arterial pressure beyond the capillaries is sufficient to push it along. Try as you will, you will find no pulse in the veins. Yet the propelling force of the heart is such that it suffices to push the blood through the veins, and even raise it against gravity from the lower extremities of the body back to the thoracic level. At intervals throughout these vessels there are placed valves which prevent the blood from any possibility of flowing backward, once it has passed within a given 'block.' It is obvious that any considerable pressure exerted by articles of clothing, such as garters, belts, corsets, etc., tends to retard the venous blood and indirectly to place a greater burden upon the heart. It is apparent also that a contracting muscle greatly aids the circulation by squeezing the blood in the veins forward from 'block' to 'block' as fast as it is received, and always in the direction of the heart.

4. *The capillaries.* The union between an arteriole and a vein is formed by the *capillary*. This is a very small tube, not more than one two thousandth of an inch in diameter and approximately one millimeter in length. The capillaries are very numerous, and so tiny that they can lie in among the cells of the various tissues. Because of their numbers, the total volume of the capillaries is hundreds of times greater than that of the arteries. Since they are so small and so numerous, the blood passing through them from the arterioles is slowed down considerably. This allows more time for

the gaseous interchange of oxygen and carbon dioxide, and for the nutritive elements borne in the blood stream to pass through the vascular walls into the cells or lymph spaces surrounding them. Figure 45 represents a diagrammatic scheme of the physiological processes which occur at the

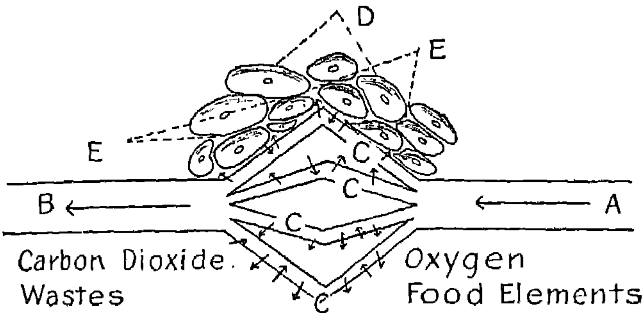

FIG. 45

Sketch to show what takes place at a capillary. The arrows indicate the passage of oxygen and nutritive particles from the blood to the inter-cellular spaces, and also of carbon dioxide and other waste products back into the blood stream. Carbon dioxide wastes. Oxygen and food elements. *A*, artery; *B*, vein; *C*, capillaries; *D*, cells of a tissue; *E*, inter-cellular spaces.

capillaries. It is evident that oxygen and nutritive particles pass out through the capillary walls, and that some waste products of oxidation thrown off by the cells pass in through them into the blood stream. The great and ultimate purpose of the circulation is to carry to the capillaries continual cargoes of nutritive substance and oxygen, and there to exchange them for return cargoes of wastes of which the body must rid itself. There is no pause or friction in this exchange of cargoes, so swiftly and silently is it accomplished. And yet throughout the entire organism, in millions of capillaries, it is continually going on. In the capillaries of the lungs, of course, the transfer of gases is in the reverse direction from that in which they move in the other capillaries of

the organism; i.e., in the pulmonary capillaries oxygen passes into the blood and carbon dioxide passes out; whereas in the systemic capillaries, oxygen passes out of the blood and carbon dioxide passes in.

Nature's means of regulating the stream's tide. It has been shown in multitudes of experiments that cardiac muscle tissue, unlike the rest of the smooth and all of the striated muscle tissues, is not dependent wholly upon the stimulus supplied by a nervous current in order to contract. If we remove the heart of an animal and place it under the proper conditions of temperature and moisture, it will continue to beat for several days and even weeks. This would seem to demonstrate the fact that the cardiac tissues possess in themselves the power to release their own stored-up energy. This does not mean, however, that there is no regulating nervous mechanism connected with the heart and blood vessels, whereby the speed of the life tide can be controlled and harmonized with the momentary circulatory requirements of the organism. Not only can Nature accelerate and retard the heart-beat; she can also increase and diminish the diameter of any and all of the arteries according as it may be necessary. Let us note briefly how these circulatory controls are operated.

Acceleration and inhibition of the heart. Two sets of nerve fibers running down from the *cardiac center* in the medulla oblongata control the force and frequency of the heart-beat. One of these, a branch of the *vagus* nerve, descends to the heart and serves to retard its pulsation; the other, passing through thoracic ganglia of the autonomic system, descends likewise to the heart, and serves to accelerate its pulsations. The suggestion has been made, inasmuch as when the vagus nerve is severed the tendency of the autonomic nerve is to accelerate the action of the heart out of all proportion to requirements, that the vagus

nerve continually holds the heart in check by an endless series of inhibitory impulses. Whenever occasion arises for an increase in the rate and force of the beat, presumably the intensity of the autonomic innervation is sufficient to speed up the heart, even against the dragging influence of the vagus. As the necessity for harder work on the part of the organ is withdrawn, the autonomic innervation is lessened, and the impulsions from the vagus suffice to restore the normal beat.

Regulation of arterial caliber. As we learned in a previous chapter (see Chapter V), the walls of the arteries include within their structures multitudes of smooth, circular muscles, which by their contraction operate to diminish the diameter of the vessels, and by their relaxation to increase it. Originating in the same general cardiac region of the medulla oblongata as the vagus nerve is another specialized group of nerves known as the *vasomotor* nerves. The center from which these nerves rise is in direct nervous communication with the sense organs of the body, and consequently reflects immediately any modification in the general bodily environment. These efferent stimuli, pouring continually in to the vasomotor center, may have either one of two influences upon it: they may prompt either *vasodilation*, or *vasoconstriction*. In the former case, a nervous impulse is sent out along neural pathways which are distributed to the circular muscles in the arterial wall, and these promptly dilate, increasing the caliber of the vessels; in the latter case, a nervous impulse is sent out along similar pathways to the same muscles, but the reaction is constriction rather than dilation. That is to say, the diameter of the vessels is diminished, and the volume of blood passing through them in a given time is consequently lessened.

The importance of the nervous mechanism which regulates the activity of the heart and the caliber of the arteries

is obviously very great. Through dilation of the blood vessels, a greater amount of blood may be sent to any organ or tissue in the body in an emergency, as, for example, when a muscle is working hard, or when there is excessive heat to be liberated, or when micro-organisms attack some portion of the body. The stomach and intestinal tract need more blood during the digestive process; the brain cells need a more copious supply when mental work is being done; the right arm and hand need richer nutriment than the left when one is writing rapidly; an infected area of dermis must be supplied with an extraordinary volume of blood in order to provide for the destruction of the microbes and prevent them from spreading throughout the organism.

When, on the other hand, a lessened tide of blood will suffice to maintain the body processes, constriction of the blood vessels occurs, and the stream is diminished. A resting muscle, for example, requires a lesser volume of circulation than a working one; when the atmosphere is harsh, and there is danger of chilling the blood, the vessels near the surface are constricted and it is withdrawn into the deeper channels of the body; during sleep the circulatory requirements of the brain — as indeed of all the organs — are smaller, and the caliber of the vessels is decreased considerably.

It is to be understood, of course, that the actual gross amount of blood in the body does not vary appreciably from hour to hour and from day to day; this means obviously that when one group of blood vessels is dilated, there must be a corresponding diminution in the size of some other group or groups elsewhere in the body. This marvelous coördination and balance is directed and maintained entirely, as we have indicated, from the cardiac center in the medulla oblongata, and is effected by nerve fibers running to the heart muscle, and to the circular muscles in the walls of the blood vessels.

Nature's means of purification of the stream's tide. Besides a careful regulation of flow, Nature has provided well for the purification of the blood stream, and by three means:

1. *By the pulmonary circulation.* In the capillaries of the lungs, as we have already noted, there takes place continually an exchange of carbon dioxide which the blood has gathered up in its circuit of the vessels, and of oxygen which the lungs have inspired. As every one knows, any interference with this normal exchange through shutting off the respiration brings suffocation within a few seconds. The blood must be able continuously to discharge its carbon-dioxide content into the lungs and replace its volume with air containing oxygen. The pulmonary circulation is one of Nature's three important purification works in the system.

2. *By the portal circulation.* That portion of the blood which goes immediately from the aorta to the *portal* organs (i.e., the stomach, intestines, pancreas, and spleen) is subsequently gathered up by the portal vein and carried to the liver, where it deposits much of the sugar, and where certain protein wastes are removed from the blood for the time being to be worked over. By means of this arrangement, the portal blood, heavily freighted with the digestive products absorbed from the intestinal tract, is made to pass through the liver capillaries before it enters the general circulation. The sugar removed here is converted into *glycogen*, which is stored in the liver cells to be used when the body requires it. The amino-acids and protein wastes extracted by the liver cells go, together with other waste substances to form *urea,* which is later either borne to the kidneys and excreted as urine, or else returned to the alimentary canal through the bile duct and excreted intestinally.

3. *By the renal circulation.* Lying at the rear of the ab-

dominal cavity, in the lumbar region, one on either side of the median line, are two organs of supreme importance in the purification process: the kidneys. Shaped somewhat like large lima beans, these organs are glands composed chiefly of microscopic tubules, at the end of each of which there is a knot of blood vessels. A branch of the abdominal aorta enters the concave side of each kidney and immediately branches into a large number of arterioles which, passing through capillaries deep in the tubules, unite to form the renal vein. During its passage through the capillaries in the kidney tubules, the blood is purified of most of its nitrogenous wastes which collect in the tubules, and are eventually poured by them into the duct, or *ureter*, and by it conveyed to the bladder for excretion.

Chemically, the waste materials thus removed by the kidneys from the blood comprise the acid urea, inorganic salts (calcium, potassium, ammonia, etc.), and water. The first of these, the urea, is a nitrogenous waste formed by the liver from certain unoxidized materials which the tissues could not use, and its prompt and regular removal from the body is essential for health. Thus do the kidneys perform one of the most significant of all the processes whereby Nature endeavors to purify and cleanse the blood stream.

The lymphatic system. If you chance to knock away a small piece of epidermis from your hand without puncturing the dermis and thereby rupturing a tiny blood tube, you will observe that the wound is immediately filled with a colorless liquid, somewhat thicker than water. This is *lymph*. The lymph is found throughout the entire organism as a watery fluid filling all the inter-cellular spaces and the lymphatics. We are not to think of the various tissues of the body as being composed of cells so tightly compressed as to leave no space for the penetration among them of this watery substance; rather we are to think of them as being packed so

loosely together that the lymph is able to pass among and between them continually.

As we already know, the nourishment and oxygen borne to the tissues of the body in the blood stream make their way out through the vascular walls at the capillaries. Along with these particles there is escaping also continually some of the liquid portion of the blood: the plasma. This same plasma, once it escapes through the capillary walls into the inter-cellular spaces, is no longer called plasma, but lymph. It can be seen at once that but for a liquid medium in which to be carried, the nutritive elements and oxygen, after they have passed through the capillaries out of the blood stream, could not be freighted in and out among the myriads of individual cells comprising a tissue, but would of necessity remain in the immediate vicinity of the capillaries—a vast and ever-increasing storehouse inaccessible to any save those cells lying directly in contact with it. This would result speedily not only in clogging up certain areas, but in the starvation of remote cells not directly in contact with it. A cell has no power actively to move from its position and seek its nutriment: it must starve unless its food is brought to its very door.

The lymph, or escaped plasma, is the medium wherein Nature's tiny barges of food and oxygen are floated in among the cells, touching intermittently at each eager wharf to discharge their life-giving burdens.

Now it is plain that, with some of the plasma continually escaping at the capillaries to carry sustenance beyond the blood vessels, unless there were provided some means of its collection and return to the blood stream the time would come very shortly when the red and white corpuscles would not have sufficient plasma to circulate them through the blood tubes. This function of collecting and returning the lumph to the blood tubes is performed by the *lymphatics*. These comprise a series of tubules of extremely small bore

which arise multitudinously in the inter-cellular spaces and which are joined together into ever larger and larger tubes until they are finally united into two ducts about the size of a goose quill, both of which empty into large veins (the sub-clavian and jugular) just under the collar bone. The one on the left, the larger, is called the *thoracic duct*, and drains all the body except the head and the right arm and shoulder. The smaller, the *right lymphatic duct*, drains only the head and right arm and shoulder.

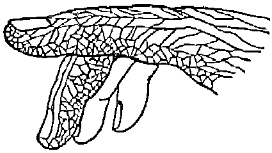

FIG. 46. LYMPHATIC VESSELS IN THE FINGERS

(From Ritchie's *Primer of Physiology*. Copyright, 1913, 1917, 1920, 1923, by World Book Company, Yonkers-on-Hudson, New York.)

What makes the lymph flow? Since there is no lymph heart in the body to move the lymph forward from the inter-cellular spaces into the larger lymphatics, and so up to the veins in the upper thorax, the question naturally arises, what makes the lymph flow? There are at least two factors responsible for this. The first is the difference in pressure between the small lymphatics in the inter-cellular spaces and the large ones at the point of entry into the jugular and sub-clavian veins. In the large veins there is practically no pressure, and since the pressure within the smaller lymphatics is high (about 40–60 mm. Hg. at the capillaries) the flow must be in the direction of the veins where the pressure is negligible. The second factor responsible for the movement of the lymph forward in the lymphatics is to be found in the pressure exerted by working muscles upon the tubes. Throughout their entire extent the lymphatics are supplied with valves which open only in one direction: toward the veins. Consequently, whenever a muscle contracts, the inter-cellular spaces within it are compressed and the lymph is squeezed from them into the ducts. Successive contrac-

tions — as in the alimentary canal during digestion, in the thorax during respiration, and in the skeletal muscles during physical exercise — operate to move the lymph forward from valve to valve until it is emptied from the lymphatics into the blood stream.

From this discussion it is obvious that frequent and regular exercise of all the muscles is an essential condition of rapid circulation of the lymph, and of prompt removal of the waste products which it is bearing from the intercellular spaces to the blood stream. Every time a muscle contracts it compresses that area of the organism contiguous with it. The more active the organism, i.e., the more muscles contracting intermittently, the more rapid and completely will the contents of the lymphatics be driven forward and returned to the blood stream. Conversely, the more sluggish the organism, the less efficient becomes the performance of the lymphatics.

Persons who lead lives devoid of multiform physical activities cannot hope to give their bodies a square deal in the matter of prompt removal of wastes through the lymphatic tubes.

An important element in the purification work of the lymphatic system is to be noted in the equipment of *lymph nodes* with which it is supplied. These are glandular structures found at intervals along the channels, and through them all the lymph is of course routed before it is returned to the vascular system.

Many of the waste products of metabolism, as well as weak and degenerate white corpuscles, are broken up in these nodes. One of the largest of them, the *spleen*, located in the upper left side of the abdomen, near the ribs, is believed to be especially active in the destruction of weak and worn-out red corpuscles that are no longer of use in the blood stream.

2. *The hygiene of the circulation*

Some chief causes of injury to the heart and circulatory system. As was pointed out in an earlier chapter (see Chapter I), the most common of all causes of death in the registration area of the United States is now some form or other of heart disease. This being the case, the problem of keeping the heart and circulatory system in a healthy condition, able to perform their proper functions unprotestingly, and to maintain high resistance power to the inroads of disease, becomes of extreme importance. In general, we may assume that if one can keep his circulatory organs robust and vigorous, and can keep the blood within them pure and clean, he will be doing everything within his power to check the development of heart trouble. The likelihood that one who can observe these precautions will be attacked by the disease is comparatively slight.

1. *Emotional storm and stress.* Among the more common causes for the somewhat disquieting increase in diseases of the heart, at the present day, should be mentioned in the first place the chronic condition of emotional storm and stress which is more or less an inevitable concomitant of our particular brand of civilization. Our bodies are built by Nature to be fairly well adapted to any emergency that may perchance to arise, as for example a thrilling theatrical performance, or a fifty-mile-an-hour clip in an automobile, or some other momentary situation which exacts a heavy toll in nervous depletion. When, however, highly stimulating situations of this sort cease to be rare and tend to become accepted and customary incidents in the daily life, the debilitating effects upon the organism in general, and upon the nervous and circulatory systems in particular, are as profound as they are inescapable.

The very intimate and sympathetic relationship between states of mind, especially of the emotional sort, and the

smooth muscles of the body, notably the heart and glands, is coming more and more to be appreciated by physiologists and medical men in general. There is very good evidence that excessive secretion of the ductless glands, such as occurs during reactions tinged with strong affective qualities, introduces into the blood stream an undue amount of irritants which are known to play havoc with the heart, in some cases violently increasing its action, in others considerably inhibiting it. When one considers the plethora of emotional appeal developed in recent years by such stimulating environmental agencies as the lure of big business, the exactions of 'keeping up' with the social demands, the appeal of 'always open' amusements, the exhaustion of 'speed' — to mention but a few of the more outstanding sources of modern disquietude — he does not find it difficult to comprehend one prominent reason why the twentieth-century American heart is in extreme danger of being outraged, if not annihilated.

2. *Overtaxing the heart.* Another source of danger is to be found in physical overtaxing of the heart, which not only drains off too much of its energy, but may even weaken and injure its tissues. As we know, the heart is a muscle, and is therefore subject to the same sort of wear and tear as other and better known muscles of the body. Every one has experienced how cramped and overworked voluntary muscles feel after they have been subjected to hard and fatiguing strain. This very morning, for example, the author, finding himself ten minutes late in getting started for his work, 'sprinted up' a bit in order to make up for lost time. He reached his office — three miles away — at the usual time, but his thigh and calf muscles have been protesting all day whenever he has climbed a flight of stairs, or otherwise called upon them to do their customary work. Fancy now the inevitable status of the poor heart! When we overtax

or strain our skeletal muscles, we can favor and rest them subsequently, but when we outrage the heart there is no redress. It cannot be 'rested up': there are always those ten tons of blood to be pumped by it within the next twenty-four hours! Not a second's respite can be taken; seventy to eighty times a minute it must 'saw wood.' Is it any wonder, then, that playing too violently in childhood, indulgence in over-athleticism or emotionalism in youth, and living under too high pressure in adulthood sear and cramp and weaken the heart until it can no longer operate unobtrusively, but makes very tangible protests to its owner? There is, of course, no way of evaluating the relative responsibility of all the known possible causes of heart deficiency; it is certain, however, that physical violation is by no means the least commonly guilty.

3. *Overeating.* A third, and certainly no less common, source of heart impairment and disease, must be placed at the door of overeating. The probabilities are that an over-hearty meal places as much strain upon the heart as it does upon the immediate digestive apparatus. The probabilities are also that an over-hearty meal places as much strain upon the heart as does a profound emotional experience, or some fairly strenuous physical performance. The reason for this is not far to seek. As we know, from the moment when food is introduced into the mouth until hours later when it is eliminated, muscular energy is being expended upon it in order to reduce it, separate its constituent parts, concentrate the nutritive portion, and distribute it and the waste portion to the proper points in the body. Now muscular energy can be supplied from but one source: the food particles in the blood stream, and the only way in which these can be carried to the muscular cells is by the circulating blood. It is apparent, therefore, that the more food one eats, the more energy the heart must put forth to supply the tissues com-

prising the digestive apparatus with nutriment to keep them functioning. In other words, in order to supply the energy to digest to-day's food, the potential energy in yesterday's food has to be consumed. If to-day's food intake has been superfluous, the energy required to digest it will be excessive, and the heart, as the ultimate energizer of the body, will be the silent but none the less obvious sufferer. From these facts it is apparent that the proper hygiene of the heart and circulatory system is conditioned in no slight measure upon moderation and good judgment in the intake of food; and, on the other hand, that overeating and gluttony comprise invariably a contributing cause to strain and impairment of the heart.

4. *Toxins.* Fourth, and finally, probably the most common source of weakness and disease of the heart is to be found in the toxic effects which are produced in the blood by the germs of disease and other extraneous poisons. Unlike the three sources mentioned above, disease poisons are largely beyond the control of the individual, and once he is attacked by disease the general toxination of his body follows inevitably. It is true, however, that by maintaining his general state of health in a high state of excellence, and by avoiding so far as possible the likelihood of contracting disease from those who are themselves ill, one may hope with reasonable assurance of success to safeguard himself from most illness, and so furnish no opportunity for disease toxins to debilitate and vitiate his body. Blood thus kept free of contamination is normally healthy and vigorous, and has in it no irritating poisons that can either score the valves of the heart or weaken its component tissues.

One of the things that make the so-called children's diseases so much to be dreaded is not the diseases themselves, but rather their after-effects. In the case of most of these, a weakened or irregular heart-action is commonly the chief

after-effect, and this may or may not be corrected by Nature. Rheumatic fever, measles, and diphtheria, because of the strain they place upon the circulatory system, and because of the frequent serious destructive effects which the toxins of these diseases have upon the heart-pump, are particularly to be guarded against by parents who are alive to the best welfare of their children, notwithstanding the commonly expressed wish of uninformed parents that their children may "get all the diseases going" while they are young.

Other diseases, more typically diseases of grown-ups, which frequently bring in their train all manner of heart complications and defects, include typhoid fever, influenza, pneumonia, rheumatism, syphilis, alcoholism, etc. To the toxins released in the blood by these and other diseases, should be added those absorbed into it from carious and decaying teeth, diseased tonsils and adenoids, and other localized areas of toxic absorption which may develop in the body. We shall have more to say about the relationship of children's diseases and defects to incipient heart impairment in a later chapter (see Chapter XII).

Prompt attention to early symptoms important. Sensible adults need to be warned to heed early signs of deterioration in the efficiency of the heart-pump, for like all other defects heart disease can usually be either corrected or checked if taken in time. Among the early symptoms that point to a weakening of this organ should be mentioned the following: (1) shortness of breath during or after physical effort that has been neither violent nor long continued enough to warrant it, and that one has previously been accustomed to perform without such accompaniments; (2) unnatural and excessive tiring at one's work; (3) palpitation, fluttering, or other irregularities in the pulsations of the heart, which operate to direct one's attention frequently to the organ;

and (4) periodic and unpleasant rheumatic twinges and neuralgias in the region of the heart. These symptoms, together with some others less common, should be sufficient notice to any intelligent person that there may be in progress within his system some process which is affecting the efficiency and perhaps the longevity of his life-pump. Competent medical advice should be sought in such circumstances, in order to insure the discovery and checking of any incipient impairment of the organ while there is yet time.

The effects of tobacco upon circulatory hygiene. In all the mass of material that has been written concerning the physiological effects of tobacco, there is relatively little of real scientific value. Much has been made, for example, of the indolence and other undesirable social traits of those students in our schools and colleges who are smokers, the contention being commonly made that, as compared with the non-smokers, the smokers are sluggish, torpid, given to idle lounging, and stand low in their studies. Many of the reports that have been made appear to be based upon the assumption that addiction to the tobacco habit leads causatively to indulgence in idleness, to the destruction of ambition, and to other unfortunate tendencies found all too commonly among students everywhere. It is quite as probable, however, that the habitual use of tobacco is but one symptom, along with the other traits mentioned, of general aimlessness of character and ambition, and that young people thus inadequately endowed or equipped with steadiness and driving force seek satisfaction and pleasure in a host of negative ways — smoking, lounging, loafing, and the rest.

Notwithstanding this flaw in many of the studies reported, there is unassailable scientific evidence that tobacco has often a decidedly bad influence upon the heart. As we have already learned, the vagus nerve has an inhibitory control over the pulsations of the heart, tending to drag down

and slow up their frequency, not unlike the brake bands on the rear wheels of an automobile. This same vagus nerve is known to be paralyzed to a partial degree at least by tobacco, and hence is unable to maintain its retarding influence firmly and evenly. Like the action of a brake band that has become worn down on one side, the pulsations of the 'tobacco heart' are jerky, uneven, and uncertain. This, of course, is reflected in the irregularity of the pulse-beat, so well recognized by the physician as an indication of 'tobacco heart.'

It must be admitted — and in this admission millions of tobacco users find grace — that not all, probably not even the majority of those who use the weed manifest even to the skilled hand and ear of the physician symptoms of the 'tobacco heart.' More users undoubtedly do not show it than do. The fact remains, however, that non-users never manifest tobacco heart! This should be a sufficient reason for those at least who are not robust physically to avoid strictly the use of tobacco, and for those who are perfectly healthy and who are victims of the habit, to indulge only in moderation. For it appears to be reasonably attested that of two individuals otherwise alike, the non-smoker will come through a serious physical illness better, and will undergo a major surgical operation with more chances in his favor, than will the smoker.

So far as children and young adolescents are concerned, the evidence is overwhelming that normal growth and the normal functioning of all the organs are distinctly handicapped by the use of tobacco. If the habit must be formed, let it wait on full maturity. Rich blood, high bodily resistance, physical vigor, and athletic prowess are for young people pearls of great price, and any way of living that is known to tarnish and take the freshness and beauty away from them is obviously wrong. And even the adult of the

modern world, having strong need for all his best powers and faculties, may well pause before he dims and removes the edge from them by addiction to a habit which the least scientific person understands to be for a great many people distinctly harmful.

Effects of alcohol on the circulation. What we have said about tobacco might be said in almost the same terms about alcohol, except that here the evidence is incontrovertible that no user — regardless of how temperate in its use he may claim to be — escapes altogether its deleterious effects. Like tobacco, alcohol has had its passionate defenders and its equally passionate denouncers. There have always been those who have waxed warm over the subtle powers of beers and wines and other drinks of low alcoholic content to brighten up the dull moments of life, to awaken good fellowship and conviviality, and to induce pleasant states of euphoria when trying circumstances surround one. Alcohol has been defended with equal warmth by those who claim to find in it a source of bodily heat and energy during or immediately subsequent to exposure to cold and wet, shock, accident, and the like. In the near past, physicians generally were inclined to look upon it as possessed of high medicinal qualities, and to employ it freely as a stimulant in certain situations. Within recent years, however, while still prescribing alcohol for many therapeutic purposes, it is an interesting fact, as Dr. Lee points out,[1] that "our best hospitals to-day use only a fraction of the amount of alcohol which they thought so essential a generation ago." It is highly probable that other less mischievous agents can be found of equal potency in the hospital, at the dispensary, in the physician's office, and in the home.

This unmistakable protest against the proverbial efficiency of alcohol in the medicinal world but reflects the

[1] Lee, Roger I.: *Health and Disease: Their Determining Factors*, p. 115

general disrepute into which alcohol has fallen in other quite different respects. Chemically denounced as possessing next to nothing to commend it as a food; scathingly condemned as a foe to the working man by employers of labor everywhere; accused by insurance companies as an enemy of longevity; and now outlawed as a beverage by our country, alcohol certainly has little left to commend and condole it. If we add to these facts the known causal relationship between alcohol and poverty, venereal disease, physical exposure, fatiguability, excesses, digestive and circulatory disturbances, not to mention the social degradation and moral pollution into which the alcoholic often not only falls himself but drags with him his family, we have proof enough of the age-long contention of the discerning members of society that alcohol is one of the greatest foes of mankind.

In the face of this condemnation, the apologists for alcohol are not able to make out a convincing case for the defense. And yet they have never lacked, nor do they now lack, for skillful and clever defenders. Some of them vaunt their own moderation in its use and deny ever being seen 'under the influence'; others point to the rivers of beer and wine that flow in other lands and the relatively negligible amounts of drunkenness in them; still others urge that the working man, to be kept contented and tractable, must have his beer; and yet others, finding no other arguments worthy their metal, become "howlers for their desecrated rights," and make up with their noisiness for their lack of good sense.

So far as the circulatory system is concerned, the most typical effect of using alcohol is to be found in the impairment of the white corpuscles. As we already know, it is these that are the defenders of the organism against the myriads of bacteria that are likely to enter it. The evidence appears incontrovertible that alcohol operates to diminish very sharply the virility of these corpuscles, and that when

attacked by disease germs the organism into whose blood vessels alcohol has been permitted to filtrate is far less able to combat them. This explains the very high susceptibility of drinkers to the ordinary so-called infectious diseases. The pneumonia patient, for example, if he is an alcoholic, may be comforted by two grim possibilities: first, that had he been an abstainer he might very possibly not have fallen a prey to the disease; and second, having contracted it, and being an alcoholic, his chances of recovery are so much the slimmer.

The principle of vaccination and inoculation. An extremely vital factor in health is, therefore, good blood. Healthy red corpuscles, in sufficient numbers, are essential to the transportation of oxygen to the various cells and tissues; strong, vigorous white corpuscles are needed to attack and destroy the germs of disease that gain entrance into any part of the organism. We may say with tolerable accuracy that a man is as healthy as his blood.

But efficient red and white corpuscles are not enough. Even though possessed of these in normal abundance, one may yet fall a prey to infectious diseases, such as small-pox, typhoid fever, diphtheria, and the like, although it is probable that of two persons exposed to any of these scourges, the one whose corpuscles are the more vigorous will be less likely to contract the disease. Modern bacteriology has demonstrated the possibility of insuring immunity to the more dread diseases by specific vaccinations or inoculations against them.

The principle of vaccination has been known incompletely for more than a hundred years, having been first practiced by an English physician, Edward Jenner, as early as 1796. Since the most remote times, the human race has been decimated periodically by mysterious scourges that have swept across entire continents and taken a heavy toll

in human life. Small-pox, bubonic plague, the "Black Death," and typhoid fever have been the most common of these epidemic afflictions. It has not been unheard of for the mortality to reach fifty per cent of the population during the attacks of these plagues upon mankind, and the most baffling part of it all was, until recently, that physicians were helpless in checking them because they did not understand them.

The principle underlying the modern preventive measures of vaccination and inoculation may be best understood perhaps by a brief paragraph on active immunity, such as nature herself sets up in the blood subsequent to an attack of measles, scarlet fever, etc. As every one knows, persons who have recently recovered from such common contagious diseases as these are not likely to 'take' them a second time, and while it is true that occasionally they do, in most instances they do not. This is because the plasma of the blood possesses the peculiar function of working up *antitoxins,* commonly called *antibodies,* during the course of an infection. These antibodies remain in the blood for a considerable period after the recovery, depending upon the nature of the disease and other factors, and possess the potency to make the organism immune to a recurrence of that particular malady for some years and even for life. This process of natural, or active, immunization takes place somewhat as follows: the microbes of disease throw off poisons or toxins into the blood stream; these at once stimulate the protective reaction of the plasma, and forthwith a prolific supply of antibodies is manufactured. These not only assist the white corpuscles in their battle with the microbes, but come in the process so to permeate the blood that whenever microbes of that same specific type appear again in the body, their activity is inhibited immediately and the organism escapes the burden of a siege with them.

This type of self-defense against disease invasions is termed active, or natural, immunization.

Passive, or artificial, immunization, i.e., immunization by means of vaccination or inoculation, is based upon this same principle of the spontaneous development of antibodies in the blood whenever germs of disease begin to pollute it. In the case of passive immunization, however, instead of waiting for the powerful microbes to attack the organism in an unguarded moment, we purposely introduce small colonies of them into the blood stream at a time when the general health is good and the blood is in an excellent condition to manufacture its antitoxins. These colonies usually consist of very much weakened or actually dead microbes that have been grown in an animal, and when they are introduced through the skin into the blood are sufficiently powerful to stimulate it to develop antibodies, but are incapable of themselves growing in the body. Thus the organism is immunized effectively against the specific disease for which inoculation was made.

Important first-aid measures for accidents involving the circulatory system. There are a few first-aid measures to be taken on occasions that should be well understood.

1. *Fainting.* Every one needs to know what to do whenever fainting occurs, as it occasionally does in stuffy, overheated rooms, or when the body is in an unusual physical or emotional condition. The immediately physiological cause back of fainting is, of course, temporary withdrawal of blood from the brain capillaries so that the nutrition of the brain cells is depleted. The important thing to do, therefore, is to aid the blood by external manipulation to resume its customary volume in the brain. Throwing open the windows so that the tonic effects of the outer air may be experienced; placing the victim in a reclining position so that his head is somewhat lower than his feet, thus enabling the

blood to flow toward the brain without the resistance ordinarily offered by gravity; loosening any clothing that binds the neck or chest, so that there may be nothing to interfere with the somewhat sluggish action of the lungs; chafing the hands, wrists, and arms in order to stimulate the circulation; application of some strongly volatile substance, such as smelling-salts, ammonia, etc., to the nostrils in order to produce reflexes in the chest — these are commonly found to be adequate measures in the restoration of consciousness. Cold water dashed in the face helps to stimulate the surface vessels, and also shocks the temperature nerves, both of which reactions foster a speeding-up of the circulation. After consciousness returns, a mild stimulant may be given the patient. For this purpose a half-teaspoonful of aromatic spirits of ammonia in a quarter-cup of water is to be recommended. The patient should then be left to rest, with some one near at hand to glance in upon him occasionally and note that he has not relapsed. He should be warmly covered and remain quiet for an hour or so. When the means enumerated above all fail to restore consciousness within a minute or two, a physician should be promptly summoned.

2. *Cut arteries.* As we already know, the blood in the superficial arteries of the body is flowing away from the heart. In the event, therefore, of an artery in the leg, arm, or elsewhere in the systemic circulation being punctured or severed, it is plain that compression applied to check the flow of blood at a point between the wound and the heart will make it impossible for it to escape from the body; if, on the other hand, the tourniquet be applied at a point *below* the injury, i.e., anywhere between the wound and the extremity of the body, the blood will flow unchecked through the lesion until the vessels have been literally emptied. Figure 47 shows this fact diagrammatically. It is im-

portant, therefore, not only to act promptly when an artery has been severed, but to act intelligently. How can one tell whether an artery has been cut, or whether it is a vein?

3. *Cut veins.* Fortunately Nature has located most of the arteries deep in our bodies, where the likelihood of severing or injuring them is least. Many of the veins are quite near the surface. You have but to look at the back of your hand to note how superficially the veins lie beneath the skin. How does the appearance of blood in veins differ from that of the blood in arteries?

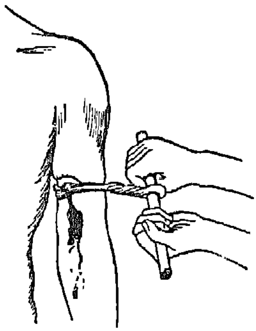

FIG. 47. CHECKING BLEEDING FROM A WOUND

(From Ritchie's *Primer of Physiology.* Copyright, 1913, 1917, 1920, 1923, by World Book Company, Yonkers-on-Hudson, New York.)

Since, as we know, the blood in the veins is traveling always toward the heart, it is obvious that pressure applied to check the flow from a cut vein must be exerted at a point *below* the injury; i.e., somewhere between it and the extremity of the body. If the tourniquet be applied above the wound, i.e., between the wound and the heart, considerable blood will continue to flow through the opened vessel. How would you reconstruct Figure 47 to illustrate this fact?

TEACHING POINTS IN THIS LESSON

A. Structure and Function

1. Number, size, appearance, and function of the red corpuscles.
2. Number, size, appearance, and function of the white corpuscles.
3. Composition and function of the plasma.
4. Location, gross structure, and function of the heart.
5. Structure, functions, and relationship of the veins, arteries, and capillaries.

6. Regulation of the rate of circulation.
7. Nature's triple process of purification of the blood.
8. Function of the lymph.

B. Hygiene

1. Effects of emotional overstrain upon the heart.
2. Some physical causes of strain upon the heart.
3. The temperate life as a physiological necessity.
4. The relationship between disease and the vigor of the heart.
5. The case against tobacco and alcohol.
6. Small-pox, its history, nature, and prevention.
7. The process of spontaneous or active immunization.
8. The principle of passive immunization.
9. First-aid demonstrations of what to do for fainting, cut arteries, and cut veins.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Look up and report upon the method used to determine the hæmoglobin content of the blood by means of the hæmoglobin color scale. What relationships does hæmoglobin content of the blood bear to malnutrition and anæmia?
2. Examine a droplet of blood under the microscope, and make a colored drawing to indicate what you see.
3. Diagram the nervous mechanism controlling the rate of the heart action. Make a list of all the situations you can think of in modern life that tend to accelerate and that tend to retard the normal rate of the heart.
4. Write a brief paper on the subject: "Temperance in all Things."
5. Look up and report upon the possible after-effects of the more common children's diseases, such as scarlet fever, measles, whooping cough, rheumatic fever, etc., paying special attention to those complications in which the heart is involved.
6. Study the effects of such agents as drugs, headache powders, and the like upon the circulatory system.
7. Outline a practical lesson you would teach to a sixth-grade class on the general subject of "The Tobacco Habit," taking special pains so to motivate it that the pupils will react thoughtfully and respectfully to it.
8. Write a brief but convincing essay on the subject: "Why Vaccinate?"
9. Make a study of the work done in your city or town in the interest of immunizing the school population against diphtheria by means of the Schick test. Gather and compare statistics from other communities. Construct curves showing the general trend in the mortality rate from diphtheria over a period of years.

10. Demonstrate, with the aid of another student, the correct procedure to follow in restoring to consciousness one who has fainted; in administering first aid to a severed artery; to a severed vein.

SELECTED REFERENCES

1. Burton-Opitz, R. *An Elementary Manual of Physiology*, chaps. 10, 11, 13, and 16.
2. Smith, S. C. *How is Your Heart?* (General Reference.)
3. Williams, J. F. *Personal Hygiene Applied*, chap. 9.

CHAPTER IX

RUNNING THE HUMAN MECHANISM: FOOD AND DIGESTION

1. *Structural approach*

The meaning of digestion. Suppose I place in my mouth a morsel of bread, chew it thoroughly, and then swallow it. May I conclude that it has then become a part of *me?* By no means, for several hours must elapse before it can be digested and ferried into the interior of my body. May I not conclude at least that when the morsel has passed from my mouth downward through the œsophagus to the stomach that it is *in* my body? Again, no; because anatomically the membrane lining the alimentary canal is continuous with the skin, and the skin is after all an external covering of the body. As well say that the ocean tide flooding up into a narrow river bed has passed into the earth. The river-banks are one with the ocean's banks, just as the stomach-lining is one with the body covering.

Food cannot be said to be *in* the body until it has passed through the membranous lining of the alimentary canal and entered the region beyond. Before this can be accomplished it must have been digested. In this chapter we are to study the process of the digestion of food from the time it enters the mouth until its nutritive portions have been passed through the walls of the alimentary canal, ferried to the cells and tissues of the body, and by them absorbed and assimilated. This whole process is a very interesting one, as we shall find.

Digestion in the mouth. As every one knows, common animal pets, like the cat and dog, swallow large morsels of

food with very little if indeed any chewing. Human beings, however, are accustomed to pulverize much of their food, especially such of it as is hard and dry. There seem to be three important results from such mastication of food. In the first place, it is torn or ground into small particles two or three millimeters in diameter, and is thus more easily swallowed; in the second place, the masticatory process serves to mix the food with the saliva secreted by the salivary glands and poured into the mouth; and finally, the rolling of the food about by the tongue and cheeks actually stimulates these glands to greater activity through the agreeableness of taste and olfaction. The importance of this reflex psychic reaction upon appetite and upon subsequent gastric secretion in the stomach cannot be overestimated.

1. *The salivary glands.* There are three pairs of salivary glands in the mouth: the *parotid*, the *submaxillary*, and the *sublingual*. The first of these, the parotid, is high up in the mouth, in front of the ear; the second, the submaxillary, is located near the angle of the lower jaw, between this bone and the tongue; the third, the sublingual, lies farther forward under the tongue. Each gland pours its secretion through a duct directly into the mouth cavity. The orifice of the parotid may be readily identified on the inner surface of the cheek, at a point about opposite the second molar tooth, as a small, rounded papilla. The combined volume of secretion from these six glands amounts to some three pints daily.

The chemical composition of saliva comprises *mucin* and inorganic salts held in solution in a large amount of water. The active principle is *ptyalin*, an enzyme which possesses the property of changing starches into malt sugar. The salivary reaction is slightly alkaline, so that when the food reaches the stomach it is rather this than acid. The lime compounds of human saliva are deposited as tartar on the

surfaces of teeth near the gums, especially at the back where, unfortunately, they are not seen.

2. *The teeth.* When one stops to think about it, he can but marvel at the clever way which Nature provides for the comminution of food into tiny particles in the mouth. The lower jaw is so joined to the head that it is able to bring the upper and lower teeth into a wide range of relationships; they can be hinged upon one another, like scissors; they can be moved forward and backward over one another, like a saw; they can be made to slide sidewise upon one another, like a rasp. Thus, food particles may be cut, torn, ground, and pulverized at will. It is interesting to note the tremendous pressure which the jaw muscles are able to exert upon the teeth. Experiments with a spring dynamometer indicate a capacity for the molars of 270 pounds, or nearly twice the weight of a person of medium size. Obviously our teeth are rarely called upon to exert this maximum pressure, yet it has been found[1] that the crushing point of cooked meat may be as high as 80 pounds; of candies, 110 pounds; and of nuts, as high as 170 pounds. No wonder it is so excruciatingly painful when one "bites his tongue."

FIG. 48. THE TEETH

This shows permanent teeth already formed in the gums, ready to displace temporary teeth.

Figure 48 indicates the permanent and temporary sets of teeth. In the first set there are twenty, while in the second set there are thirty-two teeth, the twelve molars being absent in the

[1] Cannon, W. B.: *The Mechanical Factors of Digestion*, pp. 9–10.

former. Can you see why Nature fails to provide the mouth of young children with molars? The four middle teeth in either jaw are called *incisors*, and are used especially for cutting or tearing; next outward, on either side of the incisors is the *canine* tooth, so-called from its resemblance to the prominent teeth of a dog; beyond these on either side are two *bi-cuspids*, or *pre-molars*, which have broad surfaces for grinding; last of all are the three molars, having still broader surfaces for heavy grinding. The outermost of these three — the wisdom tooth — does not ordinarily erupt until maturity. Because it is so far back, the wisdom tooth not only gets little exercise but is kept clean only with difficulty; hence it is usually doomed to early decay. The baby or milk teeth rarely last longer than the first dozen years of life, and most of them are lost by nine or ten. They have short roots in the gums and are easily displaced and pushed out by the permanent set when they begin to erupt, at the age of six or seven.

Structurally, a tooth presents three essential aspects. The outer covering of *enamel*, completely enveloping the exposed and visible part of the tooth and extending just below the surface of the gum, is very hard indeed — the hardest substance in the human body — and is not easily broken or crushed. Within this shell, forming the bulk of the tooth, is the much softer *dentine*, which decays quickly once a cavity has been opened up in the protective enamel, allowing bacterial action to reach it. Running up through the center of the dentine from the root to the crown is a long, narrow cavity, called the *pulp*, in which are the blood vessels that bring nurture to the tooth, and the nerves that supply it with life and sensitivity.

A tooth may, for purposes of easy nomenclature, be divided into three regions: the *crown*, the *neck*, and the *root*. The crown comprises that section of the tooth which is above

the gum; the neck is the section included between the surface of the gum and the bony socket; the root, ordinarily including about half the total length of the tooth, is the part firmly embedded in the jaw-bone. The incisors, canines, and bi-cuspids have but one root ordinarily; the molars ordinarily have two, and may have three, prongs. The roots are set firmly in place in their bony sockets, and held there by a cementum which is highly resistant to destruction or loosening.

The œsophagus. After the food in the mouth has been torn apart, insalivated, and formed into a soft bolus some three to five grams in weight, it is ready for deglutition through the œsophagus into the stomach. Neatly pushed on to the back of the tongue which hollows to receive it, its escape being cut off by the pressure of the sides of the tongue against the teeth, the bolus is driven by the tongue through the fauces into the pharynx, the sphincters of which grasp it and push it into the upper ring of the œsophagus. Thence, by peristaltic action, it is propelled through the successive rings into the stomach. Approximately six seconds are required for a bolus of food to make the transit of the œsophagus.

The œsophagus is a muscular tube, collapsed when undistended by the presence of food or drink in it, some nine inches in length. It forms a continuation posteriorly of the pharynx, passing downward behind the trachea through the neck and thorax, puncturing the diaphragm at left center and entering the stomach through an opening known as the *cardia.* The food bolus, as we saw, is pushed within the first ring of the œsophagus by the muscles of the pharynx; this ring forthwith contracts reflexly, and squeezes it downward into the next, which relaxes nicely to receive it; and so on, much as one might force water along a rubber tube by pushing a tight ring over it. Wave-like muscular action of this sort is known as *peristalsis* (see Chapter V). The cardia

is immediately closed after the bolus has been passed through it by the *cardiac sphincter* which guards it, preventing both food and the disagreeable odors generated in the stomach from escaping. The peristaltic action in the œsophagus of a horse may be plainly seen through the animal's neck during the process of drinking water.

Digestion in the stomach. The stomach is a pouch-shaped bag lying immediately below the diaphragm, and largely on the left side of the abdomen. The left, or cardiac, end is much the larger; the right, or *pyloric*, end is funnel-shaped, tapering down gradually to the bore of the small intestine, to which it is joined on this side. Its capacity in individuals of medium size is about two quarts, and when thus filled its length may be increased to a foot, and its greatest breadth to five inches. When empty it shrinks into very small proportions, its walls actually collapsing into folds and lying on one another. The larger, cardiac side of the stomach, known as the *fundus*, as distinct from the tapering, pyloric end, called the *antrum*, is less richly equipped with muscular fibers in its walls, it being intended apparently as a vestibule or receiving station for the food admitted at meal time from the œsophagus. It does, however, exert a moderate pressure, thus replacing the material in the antrum as fast as it is released from the stomach into the intestine.

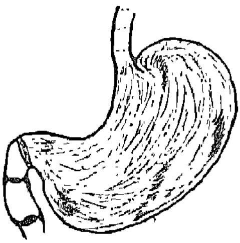

Fig. 40. The Stomach

The muscular coat of the stomach walls, particularly of the antrum, is designed to facilitate the agitation and kneading of the food, which is an important element in digestion. For it must not be supposed that once food has been admitted into the stomach it lies there inert and motionless for

several hours while the gastric juices slowly and laboriously percolate their way through it. Nothing could be further from the actual fact; almost from the moment of its entrance into the fundus, and increasingly so after it reaches the antrum, the food is kept in continual peristaltic movement by the contracting stomach walls, and is thus thoroughly mixed with the digestive fluids. These wall muscles are arranged in a triple layer: an outer layer, in which the fibers radiate longitudinally along the stomach from the cardia to the pylorus; a middle one in which the fibers are circular, passing completely around the pouch, and becoming most pronounced near the pyloric end; and an inner, or oblique layer, running transversely. By virtue of the combined supplementary activity of these three muscular coats, the stomach becomes, under distension, a sort of animated bag whose sides are alternately shortened and lengthened, and whose diameter is alternately diminished and increased. Thus the food within is thoroughly kneaded and permeated with the gastric secretion.

As we noted above, the insalivated material is alkaline upon its admission to the stomach. Inasmuch as the gastric juice is strongly acid, it very soon neutralizes the salivary secretion. Since, however, under conditions of reasonably careful mastication, the saliva is quite thoroughly mixed into the food, and since the kneading action in the cardiac end of the stomach is relatively slight, it appears that in the half-hour or hour which probably elapses before the gastric acid penetrates the food mass after meal time, the saliva has sufficient time to complete satisfactorily its action upon the starchy contents before its properties are neutralized by the hydrochloric.

The gastric juice. Embedded in great numbers in the mucous lining of the stomach are the *gastric glands*, which pour out upon the surface a very important digestive fluid,

the *gastric juice*. We owe it originally to an accident, suffered in the middle of the last century by a Canadian hunter, Alexis St. Martin, that the manner in which this secretion is exuded from the glands is understood. During a hunting expedition, St. Martin met with an accident of such a nature as to lacerate the abdominal wall and actually lay open a part of the stomach beneath. Direct medical observation of the process of digestion in the stomach was made possible during the time in which the wound was healing. Directly after a meal, the inner mucous wall of the stomach, ordinarily a neutral gray in appearance, began to flush deeply, and droplets of gastric juice were seen to well up on its surface like glistening beads of perspiration.

The daily volume of secretion from the tiny gastric glands is enormous, being estimated to be at least two quarts, and it may be three or even four. During a meal of moderate ration, 700 cubic centimeters are known to be exuded. Sometime after a meal is finished the volume is decreased sharply, and the glands remain semi-inactive until meal time again.

Chemically, gastric juice is found to be comprised of a small amount of hydrochloric acid, and three enzymes: *pepsin*, *rennin*, and *lipase*. The hydrochloric acid, besides operating to leaven the food mass into an acid condition, acts also as an antiseptic, checking and destroying the development of any micro-organisms that may enter the stomach with the food. The hydrochloric also gives tone to the sphincters at the pylorus, where the food passes, little by little, into the small intestine. Pepsin, the chief enzyme of the gastric juice, serves, with the aid of the hydrochloric, to break up the protein elements in the food into small particles, known as *peptones*. Rennin acts specifically on the protein of milk, the *casein*. It is not yet understood why the rennin causes originally soluble milk to assume in the

stomach an insoluble form, or *curd,* which must then be reduced again by the pepsin into peptones. Lipase is believed to possess some power of emulsifying the fatty elements in the food, although it certainly does little more than initiate this process. The chief action upon fats occurs subsequently in the small intestine.

After the food has been in the stomach for a period varying between a half-hour in the case of water and carbohydrates, and three to five hours in the case of proteins and fats, it is ready to be passed on into the next section of the digestive tract, the *small intestine.* It is now a thick mass, having something of the consistency of heavy cream, and is known as *chyme.* Professor Stiles makes the following excellent summary [1] of what changes the food has undergone while in the stomach:

> The material passing the pylorus is comparatively dilute and normally free from coarse particles. It is acid in reaction, both the native hydrochloric acid and the acids formed by fermentation contributing. Much of the food is as yet practically undigested. On the other hand, some progress has been made in the transformation of cooked starch into sugar. The proteins are partially peptonized. If milk has formed a part of the diet, it will have been curdled and redissolved. Fats may have been liquefied and scattered, but are not likely to have been extensively hydrolized. On the whole gastric digestion may fairly be described as preliminary in character.

Digestion in the small intestine. Opening out from the pyloric end of the stomach is the small intestine, a narrow tube the diameter of one's thumb and having a total length, when extended, of some twenty feet. It is coiled up in the abdominal cavity, occupying a considerable portion of its anterior space. The actual juncture between the antrum and the intestine is guarded by a strong sphincter, the *pylorus*, or *pyloric sphincter*, which relaxes at intervals to

[1] Stiles, Percy Goldthwait: *Nutritional Physiology*, p. 87. W. B. Saunders Company, Publishers.

permit a small amount of chyme to enter, contracting again immediately afterwards. The term *duodenum* is often applied to the small intestine, notably to the first five feet or so of it. The entire intestinal tube is surrounded by a portion of the *peritoneum*, which is a protective, friction-reducing covering found throughout the entire abdominal cavity and all its organs. It is very thin and sleek, penetrating between the organs with many folds and turns, the largest fold of all being that which ensheaths the small intestine, and known as the *mesentery*. Like the stomach, the walls of the small intestine are thickly supplied with muscles which supply peristaltic waves, since the chyme in the intestine must continue to be churned about and mixed thoroughly with the intestinal juices.

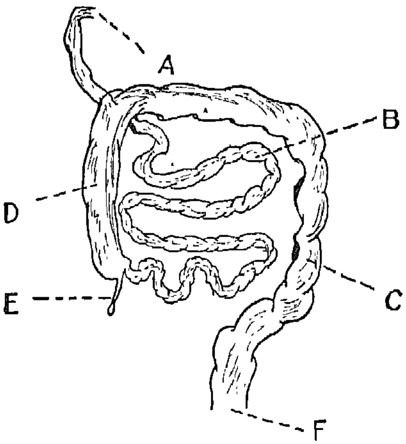

Fig. 50

Diagram to show the small and large intestines. *A*, pylorus; *B*, small intestine; *C*, descending colon of the large intestine; *D*, ascending colon of the large intestine; *E*, appendix; *F*, vent.

Peristaltic action in the intestine is, however, considerably less vigorous than it is in the œsophagus. Nor do the waves ordinarily pass along the entire twenty feet of the tube unbrokenly from the pylorus to the large intestine; rather, they spend themselves more quickly, leaving a portion of the chyme quiescent for a few moments in some loop of the intestine to be penetrated and permeated with the fluids.

Another peculiarity of the peristalsis of the intestine is that the waves may originate locally in some fold where the contained food needs to be shifted about more vigorously and persistently in order to reduce it. Actual 'segmentation' of a loop may occur for some minutes during which the contained chyme is segregated from the rest for further digestive or even for absorptive purposes.

The pancreatic juice. The *pancreatic* is one of three digestive juices secreted into the small intestine. The pancreas is a flat gland, some six inches in length, lying behind the stomach and pouring its secretion through a duct into the duodenum at a point about three inches from the pyloric sphincter. Its secretion, the pancreatic juice, is alkaline and contains three powerful enzymes: *trypsin*, *amylopsin*, and *steapsin*. Trypsin continues the action begun by the gastric pepsin upon proteins, further reducing the peptones to *amino-acids*. Amylopsin in a similar way continues the action started by the salivary ptyalin upon starches; this is a much more powerful enzyme than ptyalin, reducing the complex carbohydrates into their elemental forms. Steapsin continues the preliminary action of the gastric lipase, and under its digestive influence further emulsification and saponification of the fat globules are accomplished.

In addition to the pancreatic juice, the pancreas secretes another element, which, however, has no direct relationship to digestion, and which we mention here merely in passing. This element, manufactured by specialized cells of the pancreas, called the *islands of Langerhans*, is indispensable to the organism in the metabolism of carbohydrates. Destruction or inactivity of these cells in the pancreas leads to a very common and serious disease known as *diabetes*, in which since carbohydrates cannot be naturally metabolized, strict elimination of these foods must be made from the diet.

The bile. The second of the three intestinal digestive

juices is the *bile*, which is secreted by the liver and poured through a duct into the duodenum in the same region as the pancreatic duct. The liver, the largest of all the glands of the body, is a chocolate-colored organ lying in the upper right-hand portion of the abdominal cavity, just underneath the diaphragm. As we saw in a previous chapter (see Chapter VIII), the liver acts as a storehouse for sugar extracted from the portal vein, storing it up as glycogen until the body needs it. From the viewpoint of digestion the liver is also extremely important for its secretion, the bile. When poured into the duodenum through the biliary duct, this fluid serves greatly to stimulate intestinal peristalsis. The bile also is alkaline in its reaction, and is instrumental in the final emulsification and saponification of fats, being thus adjuvant to the steapsin of the pancreatic juice.

The bile is carried from the liver in a common duct leading both to the intestine and to the gall-bladder, the latter serving as a reservoir in which it is collected until admitted by the sphincters into the duodenum. The pigments in the bile are what give their characteristic hues to the urine and the fæces. Occasionally, due to a catarrhal condition of the bile duct which causes its partial or complete stoppage with mucus, jaundice may develop. This is a condition in which, since the bile cannot enter the duodenum, its pigments are absorbed into the lymphatics, and so reach the general circulation. They are then deposited in various tissues, notably in the whites of the eyes, and in the skin, imparting to them a pronounced yellowish hue. The digestive process in the intestine is very much slowed down, the fæces appear gray and clammy, and the greatly increased bile pigments excreted through the kidneys lend to the urine the brownish tint normally characteristic of the fæces.

The third intestinal fluid, known simply as the *intestinal juice*, is secreted immediately into the tube by small glands

which are found in large numbers in the intestinal walls. The ferments of this fluid are known to act further upon the sugar elements of the chyme.

Digestion in the large intestine. Before studying the means whereby Nature absorbs from the chyme in the small intestine the bulk of its nutritive material, it will be logical to consider for a moment the final stage in the digestive process, that occurring in the large intestine, or *colon*.

The large intestine opens by a valve from the small intestine at the lower right-hand side of the abdomen. It is about two and a half inches in diameter, and between five and six feet long. Into it are admitted at intervals from the small intestine all the indigestible substances in food, as well as a small amount of nutritive materials that have resisted the digestive action of the stomach and intestinal fluids. Between five and ten per cent of the original amount of food taken into the stomach escapes into the colon. Even here, however, Nature is too thrifty to permit the excretion of any really usable nutriment, and so she brings to bear upon the entire mass her culminative efforts at fermentation, which yield a small amount of additional material for absorption. In the colon there is an enormous multiplication of bacteria during the fifteen to twenty hours in which food commonly remains in it, and, living and dead, they pass from the body in the fæces. Most of these intestinal bacteria are quite harmless, serving merely to finally decompose the remnants of the food. The compounds produced by bacterial action on the proteins in the colon may, however, be distinctly poisonous, causing such general symptoms as dizziness, headache, and nausea.

Near the juncture of the two intestines, there arises from the colon an irregular tube, the *appendix*, which occasionally becomes invaded by microbes, causing a disease called *appendicitis*. (See Figure 50.)

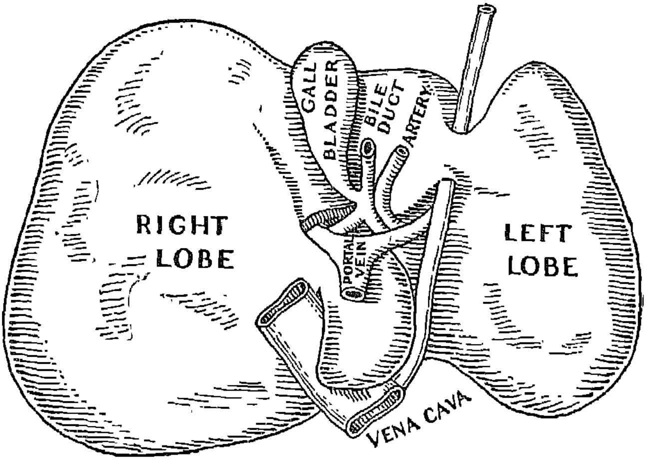

FIG. 51. THE LIVER
(From Macy and Norris's *Physiology for High Schools*, copyright. By spec'al permission of American Book Company, publishers.)

Absorption. Obviously the supreme end-point of all the churning and kneading that take place in the stomach and small intestine is the analysis of the food material into nutritive and non-nutritive particles, and the absorption of the former into the blood stream. The combined influence of peristaltic and secretive action is aimed at this essential outcome. Let us study briefly this marvelous process of absorption.

The absorption of nutriment from the alimentary canal — chiefly from the small intestine — depends upon the chemical principle of *osmosis*, or *diffusion*. If in the laboratory, for example, one places some salt, like potassium chloride, in a parchment or other thin membrane, and sets it in a solution of a different salt, say sodium chlorid, it will be found after a short interval that both have penetrated the partition, and a chemical analysis of both mixtures will show them to be

uniform. This same principle of osmosis is operating throughout the body at every point where an exchange of matter through a membrane is occurring. Instances include the transfer of carbon dioxide and oxygen in the pulmonary capillaries; in the reverse transfer of oxygen and carbon dioxide in the systemic capillaries, and in the diffusion of digested material through the membranous wall of the intestine into the blood capillaries adjoining and penetrating it.

As we indicated in the preceding paragraph, the bulk of the osmotic action in the absorption of food occurs in the small intestine. A very little absorption — especially of salts and sugars — may occur in the mouth. Some very powerful poisons, like prussic acid, are absorbed directly into the blood from the membranous lining of the mouth, causing death almost immediately. Similarly, in the stomach and in the colon some absorption of sugars and peptones takes place directly into the blood. Alcohol is readily absorbed through the stomach wall, reaching the general circulation and so the nerve cells of the cerebellum very promptly. The combined absorption from these regions of the digestive tract is, however, infinitesimal compared with that continually occurring in the small intestine.

The walls of the small intestine are covered multitudinously on their inner surfaces with tiny finger-like projections, called *villi*. They are also furrowed with innumerable cross-folds. Both the villi and the folds on the interior of the intestinal wall greatly increase the absorptive area. Running up into these folds and villi from the outside is a highly complex system of blood vessels, with their network of capillaries. Now since these vascular walls are in the closest contact with the membranous walls of the villi, it is obvious that the nutritive particles within the intestine may be readily diffused by osmosis into the blood stream. Food

substance thus absorbed is carried, as we saw, to the liver in the portal circulation. In addition to the absorptive action in the villi, a small amount of the total volume of nutritive substance in the intestine — notably the fats — is collected by the *lacteals*, tiny lymphatic tubes lying within the villi, thus reaching the blood stream by way of the thoracic duct. The proteins and sugars are absorbed directly and carried to the liver, where the latter are stored up and the former are passed through to be ferried forthwith to the hungry cells.

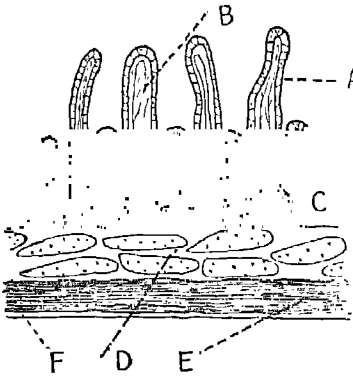

FIG. 52. THE VILLI

A, villi; *B*, loop of blood vessels and lacteals; *C*, blood vessels and lymphatics; *D*, inner coat of circular muscles; *E*, outer coat of longitudinal muscles; *F*, peritoneum.

Metabolism. The various nutritive elements analyzed out of the original food ingested thus find their way either through the osmotic absorption from the villi or through the lacteals of the lymphatic system into the blood stream. We have already traced the ferrying of these elements in the circulatory channels throughout every portion of the organism. It remains here but to refer briefly to the metabolic processes whereby these materials are built into the frame-work of the several tissues, or combine with them to produce energy.

Fats. As we noted above, the fatty elements analyzed out of the food find their way into the general circulation by way of the lymphatics. The blood supplies the moderate amount of fat needed to the body tissues for their efficient functioning, and then proceeds to deposit the surplus amount

in a specialized form of tissue, the *adipose* tissue. Even in spare people, there is considerable adipose tissue, but in obese individuals it is localized more strikingly in layers between the skin and the muscles beneath, comprising what is commonly referred to as sub-cutaneous fat. It tends to be deposited in considerable quantity along and below the lower part of the stomach and the upper abdomen. An excessive accumulation of adipose tissue is obviously not only a burden to carry about, but because of its tendency to accumulate around important organs, like the kidneys and the heart, may greatly hamper the vigorous activity and even jeopardize the longevity of these organs. On the other hand, persons afflicted with a long and wasting illness, will, other things being equal, find in a moderate amount of surplus fat a fortunate storehouse upon which the cells of their body can draw during the time in which they cannot possibly absorb and assimilate food from without. When animals die from starvation, their bodily cells are found to be entirely depleted of fat. When oxidized in the cells by union with oxygen, fats yield up their energizing influence, leaving carbon dioxide and water as end products.

Carbohydrates. We already know that the carbohydrate elements in food are carried in the portal circulation to the liver. Here whatever is not needed by the organism immediately is dehydrated and condensed into glycogen, which is stored up in the liver cells against a time of need. In case the intake of sugars is still excessive, so that the liver cannot arrest and retain them, it is now known that they too, like fat, are converted into adipose tissue, although the process cannot yet be described. Excessive sugar in the diet may also find its way into the urine and be excreted as a waste from the body. Like fats, the sugars unite with oxygen in the cells of the tissues, yielding up their energy and producing end products of water and carbon dioxide.

Proteins. At the very heart of all living organism is protein, since it is from this element in food that the cells construct and reconstruct themselves. The proteins are therefore commonly referred to as the tissue-building foods, or the building stones of the body. Meats, milk, rice, eggs, and vegetables are rich in protein content. As we have seen, the first digestive influence upon protein is that exerted in the stomach by pepsin and rennin, converting it into peptones. In the intestine the proteins are further analyzed into amino-acids by the trypsin. These nitrogenous end products of intestinal digestion are transferred to the liver, there worked over and further simplified, and are finally built into the body cells as needed. During the growth period, obviously, the assimilation of protein is far greater than it is during maturity. It is unquestionably true that the intake of protein far exceeds the nitrogenous needs of the ordinary adult individual. The chief waste product from protein digestion, particularly in the liver, is the compound *urea*, which is finally removed from the blood by the cells of the kidneys, and by them transferred to the urine for excretion.

Excretion. There are two chief sources of waste which must be eliminated from the organism. The first of these is the digestive process in the alimentary canal, which analyzes the nutritive from the non-nutritive elements, allowing the former to pass into the villi and the lacteals, but restraining the latter within the tube and moving it gradually to and through the colon. Prominent among the non-absorptive materials introduced into the body with the food are cellulose from vegetables and connective tissue fibers from animal foods. These wastes, together with dead cells, innumerable bacteria, water, bile excrements, and other compounds resulting from digestion in the alimentary canal, are excreted periodically as the fæces.

The other important source of waste materials which must be excreted from the organism is to be found in the metabolic processes occurring continually in the cells. As we have seen, the oxidation of the various food elements yields an enormous quantity of water, carbon dioxide, urea, etc., which are thrown off into the lymph to find their way shortly into the blood. Excretion must, therefore, enable the body to rid itself promptly of these end products of metabolism, as well as of the waste products of digestion.

In addition to the alimentary excretion, the organism is possessed of three other prime excretory systems: the epithelial, the pulmonary, and the renal. We have already discussed in preceding chapters the excretory functions of these three systems. It is necessary to add merely that the lungs excrete the bulk of the carbon dioxide; the skin excretes much of the water; while the kidneys excrete, in addition to water, the end products of protein metabolism, notably urea and certain inorganic wastes.

2. *The hygiene of digestion*

The problem of good digestion. There is perhaps no single group of functions of the organism that contribute more to the general well-being than those concerned with digestion. Given a good digestive apparatus, one is not only likely to be healthy of body, but tends also to be serene of spirit. Afflicted, on the other hand, with a poorly functioning digestion, one is rarely sound of body and can become and remain mentally vigorous and serene only at the expense of much schooling and self-discipline. Indeed, the mutual interdependence and interplay of good digestive tone and good feeling tone can hardly be overemphasized. This being the case, it should be apparent that the careful cultivation and preservation of a vigorous digestive system are of considerable practical importance in the general economy of human life.

It must be admitted, however, that in his carelessness and ignorance, man commits often the unpardonable sin against his highest well-being of outraging his own digestion. Over-eating; undereating; irregular eating; between-meal eating; tidbit eating; poorly balanced diet; dietary fads and whims, from drinking hot water to yeast-eating; vegetarianism and other tabus — these are but a few of the many reasons why the digestive system often suffers. Of particular importance is it for teachers to be imbued with the correct philosophy of digestion in order that they may intelligently aid their children in the building-up of proper food habits and attitudes. In the ensuing pages of this chapter an attempt will be made to analyze the best modern evidence along these lines, and to present such wise and sane rules and principles as may be helpful in properly orienting the teacher, and through her the child, to this whole subject.

What food does. We may say at the outset that food, when taken into the body, performs three important functions; in the first place, it comprises the sole source of heat and energy liberated by the organism in its daily round of work and exercise; in the second place, it furnishes the nutritive substances which the individual cells of the body require to perpetuate, repair, and maintain themselves at a high state of efficiency and tonicity; and finally, it contributes to the organism certain elements, not yet well understood, which serve to regulate and promote the normal growth and functioning of the organism. Within recent years experimental physiology and dietetics have made enormous strides, not only in determining the chemical constituency of various foods, but also in analyzing the body needs and the potential ability of foods to satisfy these needs. Much of this experimenting has operated to confirm and scientifically to approve the age-old staples in the dietaries of certain races or peoples. Thus, rice for the Chinese and potatoes for the

Irish have been amply justified as perennial staples in the diet. Much of it has operated to indicate certain definite rules and standards of diet, the observance of which should be the part of wisdom for everybody.

It must be admitted also that modern experimental nutrition has left many problems of the dietary still unsolved. One school, for example, contends that the average diet is too hearty, and could safely be substantially reduced; another claims than an intake greater than the body needs for its upkeep serves to maintain the digestive organs in vigorous condition by giving them plenty of exercise. One line of evidence looks askance on the drinking of water with meals; another recommends it as hygienic. Some decry the drinking of very cold water, claiming that it chills the stomach and retards gastric digestion; others find that it delays bacterial fermentation and is consequently to be recommended. Some octogenarians credit their longevity to strict vegetarianism; some to a liberal intake of animal protein. Some praise alcohol as a food, comforter, and cure-all; others denounce it roundly under all of these heads. Yeast-eaters, hot-water and sour-milk drinkers, and Fletcherizers represent other food extremists whose number is legion. These and other dietary ordeals and practices are confusing in the extreme to the average individual, who is inclined — and somewhat rightly — to eat what he likes and as much as he pleases. As between these two extremes there is undoubtedly a middle course which he who would govern his life by wisdom should steer. The wisest philosophy is to eat in order to live, rather than to live in order to eat, and it behooves us here to pass briefly in review some of the more important dietary principles which are now considered well established.

Important factors determining one's diet: Certain important conditioning factors should be mentioned and emphasized at this point.

Occupation. It has been said very pointedly that what is one man's meat is another man's poison. While of course not literally true, this saying applies with peculiar aptness when we consider the food needs of the organism from the occupational viewpoint. As we already know, the prime service performed by food in the body is to supply it with the fuel and repair material necessary for its functioning. It is obvious that the individual who leads a daily life involving vigorous muscular exercise in the open will be using up more energy and will require a greater replacement store than an individual who leads a sedentary life largely indoors. It would be the height of folly for the former to endeavor to subsist on a diet sufficient for the latter, or for the latter to gorge himself on that needed by the former. The farmer, truckman, blacksmith, day-laborer, and hod carrier represent metabolism proceeding at its maximum rate, as do the athlete, hiker, mountain-climber, and cyclist. On the other hand, the student, teacher, office worker, secretary, and professional man represent a greatly decreased rate and amount of metabolism, and consequently require a much less substantial ration.

The lowest level of metabolism for everybody, of course, is reached during sleep, when there is a minimum of muscular activity expended and when there is generated but a relatively small amount of heat to maintain the body temperature. Under such conditions of rest it has been estimated that fifty or sixty calories per hour suffice to meet the metabolic needs of the organism. At the other extreme, representing the maximum ever observed under experimental conditions, is the case of a professional bicycle rider, pedaling to the height of his ability and endurance upon a stationary bicycle inside a calorimeter;[1] his metabolism

[1] An air-tight chamber, or room, enclosed within a jacket of water whose temperature is measured by a thermometer. The subject within receives oxygen in definite amounts and at known rates through a tube. The amount of heat liberated is an index of the amount of metabolism occurring under various conditions of exercise, rationing, etc.

reached 600 calories per hour. Athletes working at the limit of their endurance may metabolize 9000 calories in a day. Atwater recommends [1] 4150 calories for a man engaged in hard muscular work, 3400 for a man engaged at moderate muscular work; 2700 for a man engaged in sedentary work; and 2450 for one getting no muscular exercise. With reference to brain workers, Stiles concludes [2] "that no more food is needed by the student occupied with his books than for the same man at leisure." Modern experimental dietetics suggests: (1) that the volume of food ingested should bear a reasonable relationship to the amount that is needed for the daily metabolic processes of the organism; (2) that the greater the release of energy through muscular exercise, the greater the ration needed; and (3) that conversely, the more sedentary and inactive the way of living, the more sharply the intake of food should be gauged. The same line of evidence points rather distinctly to the conclusion that most people, if they do not actually 'dig their graves with their teeth,' undoubtedly overeat, and would be more healthy and vigorous if they would cut their food consumption by 25 per cent.

On this latter point, Professor Stiles says: [3]

> The claim is often made that the average food practice of mankind must be the expression of a correct biologic instinct. Against this it is urged that our own generation may inherit appetites which were adapted to spur our ancestors to find food when the quest was difficult. Such appetites may be false guides when no effort is required to obtain the means of satisfaction. Variety of food may lead to over-consumption. Modern conditions make it possible to have many kinds of food and interesting contrasts of flavor which encourage eating for sensuous gratification. The primitive diet was monotonous and unseasoned.

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[1] United States Department of Agriculture, *Farmers' Bulletin*, no. 142. Storrs, Connecticut, 1903.

[2] *Nutritional Physiology*, p. 192.

[3] *Op. cit.*, p. 208.

Think over these 'modern conditions,' which provide ice-cream, cool beverages, cane-sugar candies at every street corner, alluring fruits from the tropics within easy reach of every housewife, and the modern cooking conveniences and methods which encourage the making of attractive and tasty dishes in every home and at every meal time. Is it any wonder that modern man is in grave danger of overeating? It is a pretty good rule to form to leave the table always a little hungry, although it may require yeoman self-mastery for the first half-dozen or so meals. Better this than to surfeit the organism with too much food, thus not only placing needless strain upon the digestive system, but rendering the subject uncomfortably full, torpid, and sluggish.

Age. What fond mother has not remarked wonderingly at the food capacity of her fifteen-year-old boy, who consumes more than his forty-five-year-old father? There are at least two good physiological reasons for this seeming disproportion between the metabolism of the child and that of the adult: the factor of growth, and the known condition of greater metabolism in the former. The first of these, growth, may be dismissed without comment, it being obvious that the nutritive needs of the grown-up are satisfied when replacement of the cellular substance broken down by the day's work has occurred, while those of the child under the domination of the growth-impulse include not only this replacement, but the energy required for systematic increase of his body machine in size and weight.

The second factor, greater metabolism in the young, requires an explanatory statement. It is a well-known biologic principle that the body loses heat in proportion to the extension of its surface, and that in proportion to weight the small body has a much greater surface than the larger one. This means obviously that, since the heat loss of the child is greater in proportion to his body weight than that of the

adult, the former requires relatively more food than the latter. Thus an infant weighing only one sixth as much as a man produces approximately one third as much heat, or some 700 calories. The adult body area is nearly two square meters, and if we consider 2000 calories the minimum adult metabolism this should mean that 1000 calories per square meter of body surface are needed for proper body maintenance. The body area of an infant weighing twenty-five pounds will approximate two thirds of a square meter, and the metabolism will amount to about 700 calories. Thus, estimating comparative metabolism on the basis of body area, the food requirements of both child and adult are not disproportionate. The reason why the generous food consumption of the youth is often remarked upon is due, of course, to the fact that the naïve judgment estimates metabolism on the basis of *youngness* rather than relative body area, which is the proper criterion.

Age, then, is a factor of some importance in the selection and amount of food needed. By virtue of his greater muscular activity and his continuous growing the child needs a liberal dietary; as Williams remarks:[1] "a young person fourteen to seventeen years of age may need more fuel than one thirty years of age." Under a subsequent caption we shall analyze more specifically the types of food needed by children to promote their normal growth, and to provide the requisite metabolic needs of their bodies.

Climate and season. In addition to these two prime factors determining the dietary, two others should be mentioned: climate or season, and the personal chemistry of the body. It is a fortunate provision of Nature that the available food supply of man corresponds everywhere so wisely with the climatic influences under which he lives. Thus the Eskimo, living in the frozen North, finds in the flesh of the

[1] *Personal Hygiene Applied*, p. 180. W. B. Saunders Company, Publishers.

seal the heat and energy which he needs in abundance to keep his body warm; while the northern African, living in the tropics, receives nutriment ample for his needs in the cooling fruits, vegetables, and lighter game that abound in his habitat. The latter would be surfeited and nauseated in short order by the 'heating' diet of the former, while the Eskimo would perish of cold if not of hunger if deprived of his blubber and oil. For those of us who live in temperate regions, which to a degree approach the severity of the polar regions in mid-winter and the mildness of the equatorial region at mid-summer, it is important to choose our dietary wisely and with some careful reference to the seasonal needs. The writer recalls very vividly making a pilgrimage to a *small city in northern New England on a Fourth of July* holiday, some years since, with the thermometer hovering closely about 100° F. at noontime, only to find featured on the bill-of-fare in the restaurant — hot roast pork, with 'stuffing' and gravy! He beat a hasty retreat! Meat of any kind, and by all means pork, is to be largely avoided in hot weather because of its well-known heating effect. For the same reason, it should represent a common staple in the cold weather dietary. In summer we need plenty of greens and fresh vegetables, salads, berries, and fruits. In winter we need, in addition to such of these as are available, meats and their products in greater abundance. The wise housewife and mother plans and regulates her daily menus somewhat in accordance with the thermometer, and with the seasonal needs of the body.

Personal chemistry of the body. Every one knows that foods easily digested by one individual are often very unsuited to the digestive apparatus of another individual, causing disturbances of varying degrees of severity. While fortunately this is not ordinarily true of the staple foods, it is commonly true of supplementary foods. Experimentation

along this line has thus far been somewhat meager, but has sufficed to indicate that the body chemistry varies somewhat as between individuals, so that foods that are readily reduced in the alimentary tract of one person may either remain quite undigested in that of another person, or may actually supply the stimulus for vigorous rebellion along the canal. This peculiarity is not of course to be confused with whims and fanciful aversions which many people form for certain types of foods, but represents an actual chemical condition of the organism which is beyond the control of the individual. Indeed, it is often also the case that the personal chemistry alters markedly within the same individual, causing him to react quite uncharacteristically to certain foods on occasion.

The safest and sanest rule is to eat what one knows from daily experience is digested without difficulty or discomfort, and to refrain from eating whatever is known through repeated experience to disagree with one.

Classification of foods. We may classify the articles of food comprising the human dietary, according to the chemical compounds contained in them, into three distinct foodstuffs: carbohydrates, fats, and proteins. In addition to these, certain subsidiary foods in a well-organized diet will be discussed under minerals, and vitamins.

1. *Carbohydrates.* This class of foodstuff, eventuating as we have seen in carbon dioxide and water, includes sugars and starches. These, stored as glycogen in the liver, are reconverted into circulating sugar and ferried to the tissues as they are needed. The particular tissue that demands sugar is the muscular, it being a fact well established by physiologic chemists that every time a muscle contracts it uses up a small quantity of sugar, which must be immediately replaced by the circulation in order for the contractions to be continued. Carbohydrates are therefore indispensable

elements in the dietary. In case an excessive amount of carbohydrates is included in the diet over and above the amount demanded by the muscular activity, and required for reserve storage in the liver, it may be converted into fat and stored as adipose tissue. Common types of obesity, it appears, may be as commonly traceable to over-indulgence in sweets and other foods high in starch and sugar content as to an excess of fatty foods.

The bulk of our carbohydrate intake arises from grains and pastries. The former include, of course, wheat, oats, barley, corn, rye, cereals, bread, macaroni, and rice, wheat being the richest in starch content. The latter represent products of the culinary art, in which cane sugars are used extensively, and include pies, cakes, puddings, and the like. Other common sources of carbohydrates include fruits, molasses, syrups, honey, jellies, candy, and of course plain uncooked sugar as sweetening in beverages and on desserts. These, then, are the foods whence our bodies derive much of their heat and energy, and are often referred to as "foods to yield energy." It will be noted that animal foods are not included within this group.

2. *Fats.* Like the carbohydrates, fats give energy to the body, and yield a final oxidized product of carbon dioxide and water. They are also stored in various tissues — notably the sub-cutaneous — for use as fuel at a later time, or on a 'rainy day.' A gram of fat yields more than twice as many calories as a gram of carbohydrate; fat is therefore a source of high energy as compared with starches and sugars. Our chief dietary source of fats comprises milk, and its products, butter and cream; and the fat of meat, nuts, lard, and other vegetable oils, cooking fats, bacon, etc.

3. *Proteins.* As we have seen, the proteins are the great 'tissue-building' foods, supplying the sole source of nitrogen obtainable by the body, and producing as an end

waste-product the acid urea. Both animal and plant food supply this class of compound in our dietary. Animal proteins comprise lean meats, fish, and eggs. Prominent among the vegetable proteins are bean, peas, and nuts. Milk and cheese are also rich in protein, as are also wheat and maize.

With reference to the utilization of meat as the major source of protein, it should be pointed out that the elimination of urea and other wastes of protein, which falls largely on the kidneys, puts an added strain upon these organs in the case of animal proteins because they contain certain subtle end products, called *purins*, less easily extracted. It is therefore commonly recommended by dietitians that meat appear on the menu not oftener than once a day, some form of vegetable protein being substituted at the other two meals. Rose says,[1] in this connection:

> These purins are not nutritious, but are gradually transformed in the body into uric acid, to be carried off as waste in the urine. Persons inclined to gout have difficulty in getting rid of uric acid, and the more meat they eat, the more uric acid tends to accumulate in the system, circulating in the blood and depositing in the joints. If protein is taken in moderation, and chiefly from eggs, milk, cheese, bread, and nuts, which contain no purins, dangers of this difficulty may be avoided.... For persons of indoor, sedentary life a very liberal use of meat is certainly undesirable.

4. *Minerals.* Another important element in the dietary may be classified under the general term of *mineral salts*. These in no wise assist in the production of heat or energy, but are known to be essential to the building of certain tissues, especially bony, and to the maintenance of the general tonicity of muscles and nerves. Any reasonable diet contains many of these minerals, such as sodium, potassium, and magnesium, in abundance. Other mineral

[1] Rose, M. S.: *Feeding the Family*, p. 68. Reprinted by permission of The Macmillan Company, Publishers.

elements needed, however, such as calcium, phosphorus, and iron, are found less regularly distributed in foods, and some care needs to be exercised that they be included. Milk is especially rich in calcium, and this fact alone would justify its daily inclusion on every table in the land.[1] Fruits and vegetables are also excellent sources of calcium. Phosphorus, essential also in the normal development and maintenance of the body tissues, is found in greatest abundance in the leaf vegetables, such as spinach, cauliflower, celery, lettuce, etc. Iron is needed to form the hæmoglobin of the blood, and exists in sufficient quantity to meet the needs of the organism in green vegetables, notably spinach, and in fruits, milk, eggs, and whole-wheat flour. Blood remedies advertised to replenish a deficiency of iron are a delusion and a snare, none of them containing anything like as rich and economical a source of this material as is to be had in such common foods as eggs, milk, prunes, beans, etc.

The vitamins. It has until somewhat recently been supposed that, providing one ate certain common foods in the proper amounts, health, in so far at least as diet is concerned, would take care of itself. Such common foods were assumed to be limited to protein, carbohydrate, and fat, with a seasoning of iron, calcium, and phosphorus. In recent years, however, the results of certain careful experiments upon animal nutrition have tended to upset our theories, at least partially, by suggesting the necessity of three additional food materials in the diet which previously had not been heard of by the laity, and had only partially been understood by the chemist.

Experimenting in 1881 upon the diet of mice, Lunin dis-

[1] Owing to its peculiar composition, milk is one of the finest all-round foods. It contains sugar, fat, protein, calcium, and all three vitamins, thus rightly meriting the distinction so often accorded it of being a "perfect food."

covered that while mice could live for an almost indefinite period upon a diet of milk, they succumbed very quickly (i.e., within a month's time) when fed a diet of what are commonly believed to be the essential ingredients of milk — casein, fat, milk sugar, and ash. From these experiments he concluded that there must be in milk certain indispensable elements besides those commonly known.

Following the pioneer work of G. Lunin, F. G. Hopkins, an English scientist, T. B. Osborne and L. B. Mendel, of Yale, and E. V. McCollum and M. Davis, of Johns Hopkins, have succeeded in establishing the existence of three accessory food elements in certain substances, and to them the name *vitamins* has been given. Thus far, it is true, no one has succeeded in actually isolating any of these three elements, nor in analyzing very accurately their chemical or physical properties.[1] Experiments in the diet of animals, however, have seemed to demonstrate beyond a doubt the presence of all three of them, and probably others, in certain food products. As to how great quantities of them are requisite to the diet of human beings, and how great quantities are contained in foodstuffs, nobody yet knows. About the only positive information we have, in addition to the knowledge that they exist, is that a complete lack of these elements in the diet may and does lead to actual disease, and that too great deficiency in them may be responsible for ill-health and retarded growth in the young.

[1] It should be pointed out in this connection that a considerable amount of experimentation into the nature of vitamins is being carried on in various laboratories. Since these paragraphs were written, for example, Dr. W. A. Eddy, of Columbia University, has been successful in extracting from yeast a vitamin substance pure enough to be crystallized and analyzed. Experimentation has also revealed, in addition to Vitamins A, B, and C, at least two others: Vitamin D and Vitamin E, the former appearing to control to a considerable extent the metabolism of lime and phosphorus in the formation of bone, and the latter, the anti-sterility vitamin, contributing to the fecundity of certain animals on which tests have been made.

The names which the investigators have given to these three mysterious food elements are: (1) *fat soluble A*, (2) *water soluble B*, and (3) *anti-scorbutic C*.

Vitamin A. (Fat Soluble A.) This vitamin owes its name to the fact of its solubility in fat. It is found chiefly in solution in animal fats, butter, cream, egg-yolk, beef fat, fish oils, etc., but does not occur to any appreciable extent in vegetable oils. In addition to these, Fat Soluble A is found commonly in two other sources: glandular organs (liver, kidneys, pancreas) and leaves of vegetables (asparagus, Brussels sprouts, cabbage, lettuce, celery). It is believed that Fat Soluble A is of prime importance in the promotion of normal growth in young people, and that it acts as a preventive against rickets, on the one hand, and xerophthalmia (a vicious disease of the external coating of the eye) on the other.

The history of the diets prescribed for tuberculosis sufferers throws an interesting light upon the importance of Fat Soluble A. It has long been known that a generous dietary reacts favorably upon the tuberculous patient, and now comes the significant revelation that those very foodstuffs most universally regarded as essential in the feeding of consumptives are particularly rich in Fat Soluble A. Among such foods may be mentioned cream, milk, butter, eggs, cod liver oil, etc.

Dietitians are now recommending that at least one of the foods containing Fat Soluble A should appear daily in the diet of growing children if they are to grow normally and maintain their health in prime condition. It is likewise essential that adults, in the interest of strength and resistance power, should see to it that such foods find a prominent and constant place in their menu. Of particular importance is it that pregnant and nursing mothers should have a liberal supply of Fat Soluble A in their diet. In this connection it

is pointed out that bottle-fed babies are not the only ones who are subject to attack from rickets. Breast-fed infants may, if the mother's milk is deficient in Fat Soluble A, fall easy prey to this disease, since obviously their only source of supply of this very essential element is the milk of the mother. Not only is the infant whose diet lacks the proper amount of the soluble incurring the risk of becoming rickety, but in addition it is suffering deprivation of a substance which seems to be indispensable to normal growth at a period when the growth impulse can ill brook any interference.

Vitamin B. (Water Soluble B.) As its name would indicate, the second of the important vitamins may be dissolved in water, and is often referred to as Water Soluble B. With the exception of white flour, white rice, sugars, starches, and fats, and possibly a few other foods, this soluble is found in some quantities in all natural foodstuffs. Hence there is little danger of any diet being deficient in it. The chief sources of water Soluble B are the seeds of plants, eggs, and highly cellular organisms, such, for example, as liver and heart. Flesh contains comparatively little. Yeast cells are a rich source of this element, hence the modern popularization of the eating of yeast as a cure-all. In the legumes (peas and beans) the soluble is distributed tolerably evenly throughout the seed, whereas in the cereal grains it is concentrated in the outer layer. Consequently the milling process removes the greater part of Water Soluble B, which remains in the bran. For this reason bran is believed to be a very essential adjunct to the dietary.

Since Water Soluble B is dissolvable in water, it tends to cook out of vegetables that are boiled, and if this water is thrown away the vitamin is obviously lost. Whenever possible, therefore, such water ought to be made use of in soups or gravies. Vegetables baked or steamed, rather than boiled, preserve the soluble intact so that its value as a

vitamin is not lost. Water Soluble B appears an essential in the diet as a promoter of growth in the young and as a preventive of antineuritic conditions, also beri-beri.

Vitamin C. (Anti-Scorbutic C.) The third vitamin has been named Anti-Scorbutic C, in recognition of its virtue as a preventive and cure for scurvy. Like Water Soluble B, it is soluble in water. Among the most common sources from which we derive this vitamin are fresh vegetables and fruits. Foods that are richest in this element include lettuce, cabbage, turnips, tomatoes, raspberries, oranges, and lemons. Potatoes, while relatively poor in content of Anti-Scorbutic C, probably are the chief preventive against scurvy in the northern countries where other vegetables are rare by reason of the fact that they comprise a very large part of the diet. Dried vegetables, it is interesting to note, are deficient in Anti-Scorbutic C, as are all canned vegetables and canned meats. Canned fruits and tomatoes, on the other hand, because of their acidity, increase the stability of the vitamin and its destruction is consequently in a measure prevented, although it exists in less quantity than in the fresh fruit.

In environments where fresh vegetables or fruits are not available, Anti-Scorbutic C may be supplied in sufficient quantities for the dietary by means of moistening the available seeds, such as wheat, barley, rye, peas, beans, and lentils, and allowing them to sprout. Sprouts on vegetables thus treated are relatively rich in content of Anti-Scorbutic C, and may be cooked (the shorter time the better) and served in the ordinary way.

All bottle-fed infants require an extra anti-scorbutic, since cow's milk, even when raw, is poor in this element, and when heated or Pasteurized or otherwise preserved, the vitamin is still further reduced. The best anti-scorbutic food to use for this purpose is orange juice, although tomato

juice and grape juice are excellent. In the case of breast-fed babies, it is important that the diet of the mother contain an adequate supply of fresh fruit and vegetables.

Importance of vitamins in the diet. It is now pretty generally admitted that failure to include these vitamins in large quantities in the diet not only may result in retarded growth and development and a lessened resistance to disease in childhood, but may actually be responsible for lowered resistance power in adults, and even lead to such specific diseases as rickets, scurvy, xerophthalmia and beri-beri. The effect upon the nervous system of a dietary deficient in these important elements may be profound, and it has been demonstrated by scientists that a diet otherwise adequate, if deficient in vitamins, will lead in many cases to abnormal development of the bony tissue, particularly of the teeth. Absence of vitamins may be a cause of prolonged retention of the temporary teeth, delayed eruption of the permanent set, irregularity in alignment, defective enamel, decalcification, and even loosening of the teeth.

Important as are the vitamins in the adult dietary, they are even more so in the diet of the growing child, if development is to be regular and growth normal. It would be an extremely interesting thing if we could know approximately what percentage of the malnutrition, rickets, and other disorders of growth and development in children of school age is traceable to deficiencies in vitamins. The indications are that the percentage would be a high one.

The recent research into the nature and value of the vitamins has served to complicate still further the already complex problems of health and disease. Taken together with modern discoveries of the action of the glands of internal secretion, and their relationship to normal functioning of the organism,[1] this newest discovery serves to emphasize

[1] For an excellent account of the activity of the ductless glands, see *Body Changes in Pain, Hunger, Fear and Rage,* by Walter B. Cannon.

anew the age-long problems connected with the efficiency of the human machine, and to suggest that after all many of the secrets of health and disease have not yet been ferreted out.

Distribution of vitamins in certain foods. In the table below,[1] are presented certain food materials in which experimentation has demonstrated rich vitamin content. The sign + indicates the presence of the vitamin; + + indicates the food is a good source of the vitamin; + + + indicates the food is an excellent source of the vitamin.

TABLE 6. INDICATING FOODS HIGH IN VITAMIN CONTENT

Source	Vitamin A	Vitamin B	Vitamin C
Codliver oil	+++		
Liver	++	++	+
Lemon juice		++	+++
Orange juice	+	++	+++
Raspberries			+++
Tomatoes, raw or canned	++	+++	+++
Kidney beans		+++	
Soy beans		+++	
String beans	++	++	++
Raw cabbage	+	+++	+++
Carrots	++	+	+
Dandelion greens	++	++	+
Lettuce	++	++	+++
Onions		++	++
Peas	++	++	+
Potatoes, boiled		++	++
Rutabagas		++	+++
Spinach	+++	+++	
Milk	+++	++	+
Butter	+++		
Cream	+++	++	+
Eggs	++	+	+
Yeast		+++	

The table above by no means exhausts the list of demonstrated vitamins; it does, however, represent those foods

[1] Adapted from *The Vitamins*, by H. C. Sherman and S. L. Smith, pp. 208–213. The Chemical Catalog Company, Inc., Publishers.

which have been found to be their best sources. It will be noted that certain foods, such as tomatoes, cabbage, and lettuce contain an abundance of all three vitamins.

Fuel values and body needs. As we have seen, food when burned (i.e., oxidized) in the body yields varying amounts of heat, and for this reason all articles of food may be said to possess *fuel value*. It is desirable to have some unit for measuring the fuel value of foods. Such a unit has been satisfactorily established in the *calorie*, and may be defined as the amount of heat required to raise the temperature of one kilogram of water (about one quart) one degree Centigrade. The *calorimeter*, in which the fuel value of foods is determined, consists of a hollow metal cylinder, or 'stove,' completely immersed in a tank of water. This tank is insulated and supplied with thermometers. As the food within the cylinder is oxidized by means of an electric spark, the heat from it is conveyed through the metal wall into the water, the rise of whose temperature is accurately gauged by the thermometers. It is thus possible to calculate the caloric energy of any food product, due allowance and correction being made for any incidental and unavoidable escape of heat from the apparatus.

Fats are found to have the highest caloric value, one gram yielding slightly more than nine calories. Carbohydrates and proteins are about equal in caloric value, a gram of either yielding about four calories. Knowing the metabolic daily needs of the body at various ages in terms of total number of calories, and also the caloric value of unit quantities of all common foods, it becomes a very easy as well as an interesting task to plan out the daily menu for the family, insuring ample nutrition for every one.

The following table represents, with reasonable accuracy, the average caloric needs of individuals of various ages during each twenty-four hours.

TABLE 7. SHOWING CALORIC NEEDS AT DIFFERENT AGES

AGE (years)	TOTAL CALORIES IN 24 HOURS
5	1500
6	1600
7	1700
8	1800
9	1900
10	2000
11	2200
12	2400
13	2600
14	2800
15	3000
16	3200
17	3400
18–25	3600
Adults	Variable

It will be easy to remember these caloric needs if the student will note that for the years 5–9 inclusive, the figure representing the calories suggested is made up [1] by placing '00' after the year, and a '1' before it; thus 5 years = 1500 calories; 6 years = 1600 calories, etc. Similarly, for the ages 10–18 inclusive, by multiplying the year by '2' and annexing '00' the calories suggested for that year are obtained. Thus: 10 years = 2000 calories; 11 years 2200 calories, etc. It has not been deemed wise to recommend any specific number of calories for adults, since, as we have seen in an earlier section, the type of work performed habitually is an important determining factor upon the metabolic needs.

Even in the case of children and adolescents, as included in the above table, it should be borne in mind that no set recommendation can be made to cover the caloric needs of all individuals. At best, charts of this sort, like height-

[1] This is suggested, of course, merely as a mnemonic device, the above calorie table being constructed a bit freely by the author to help the student actually to remember the approximate needs of the body at different ages. It will be found, however, reasonably accurate and satisfactory.

weight charts (see Chapter II), are not to be interpreted as setting absolute standards for everybody, but rather as suggesting approximate averages for typical individuals. Underweight children need obviously more calories, other things being equal; overweight children may need fewer. Most adults, by watching the calories and exercising properly may undoubtedly 'eat and grow thin,' or at least 'eat and stay thin.' It is probable, however, that heredity and general body chemistry play important rôles in determining the build and weight of the adult organism, and that within certain limits only can weight deficiencies be corrected by increasing the food intake, or the opposite by decreasing it moderately.

The perennial solicitude of many people about the rationing of their organism may, of course, be carried to absurdities. The other extreme of carelessness and indifference, however, in this regard is equally reprehensible. The wise housewife, without too much pettifogging, will endeavor to select and prepare her meals with some moderate degree of scientific exactness, striving (1) to arrange well-balanced menus; (2) to provide variety; and (3) to include the accessory vitamins and minerals in liberal amounts.

Caloric values of certain common foods. It is, of course, quite beyond the scope of the present work to enter into any exhaustive study of the caloric values of foods. We shall have to be content merely to present in the accompanying table on pages 267–68 the values of a few of the more common ones in terms of their composition and their caloric yield.

How to plan the menu. "What shall we have for lunch?" "What shall we have for dinner?" "What shall we have over Sunday?" These are among the most commonly asked questions in our homes, and rightly so. To plan the food for a family three times a day, seven days a week, fifty-two weeks a year, is no small task for the housewife and mother. All honor to her for this ever-pressing duty

TABLE 8. INDICATING THE COMPOSITION AND CALORIC YIELD OF CERTAIN COMMON FOODS

Food Material	Protein (per cent)	Fat (per cent)	Carbohydrate (per cent)	Mineral Matter (per cent)	Calories per Pound
Beef					
Loin	16.1	17.5	....	0.8	1025
Ribs	13.9	21.2	....	0.7	1135
Round	19.0	12.8	....	1.0	890
Shoulder	16.4	9.8	....	0.9	715
Dried and smoked	26.4	6.9	....	8.9	790
Veal					
Leg	15.5	7.9	....	0.9	625
Loin	16.6	9.0	....	0.9	685
Breast	15.4	11.0	....	0.8	745
Mutton					
Leg	15.1	14.7	....	0.8	890
Loin	13.5	28.3	....	0.7	1415
Flank	13.8	36.9	....	0.6	1770
Pork					
Loin	13.4	24.2	....	0.8	1245
Ham, fresh	13.5	25.9	....	0.8	1320
Ham, smoked and salted	14.2	33.4	....	4.2	1635
Bacon	9.1	62.2	....	4.1	2715
Chicken	13.7	12.3	....	0.7	765
Turkey	16.1	18.4	....	0.8	1060
Goose	13.4	29.8	....	0.7	1475
Eggs	13.1	9.3	....	0.9	635
Cod, fresh	11.1	0.2	....	0.8	220
Cod, salted	16.0	0.4	....	18.5	325
Mackerel, fresh	10.2	4.2	....	0.7	370
Herring, smoked	20.5	8.8	....	7.4	755
Salmon, canned	21.8	12.1	....	2.6	915
Oysters, shelled	6.0	1.3	3.3	1.1	225
Butter	1.0	85.0	....	3.0	3410
Cheese	25.9	33.7	2.4	3.8	1885

TABLE 8 (*continued*). INDICATING THE COMPOSITION AND CALORIC YIELD OF CERTAIN COMMON FOODS

FOOD MATERIAL	PROTEIN (per cent)	FAT (per cent)	CARBOHYDRATE (per cent)	MINERAL MATTER (per cent)	CALORIES PER POUND
Milk, whole	3.3	4.0	5.0	0.7	310
Milk, skimmed	3.4	0.3	5.1	0.7	165
Oatmeal	16.7	7.3	66.2	2.1	1800
Corn meal	9.2	1.9	75.4	1.0	1635
Rye flour	6.8	0.9	78.7	0.7	1620
Buckwheat flour	6.4	1.2	77.9	0.9	1605
Rice	8.0	0.3	79.0	0.4	1620
Wheat flour — white	11.4	1.0	75.1	0.5	1635
Wheat flour — Graham	13.3	2.2	71.4	1.8	1645
Wheat bread — white	9.2	1.3	53.1	1.1	1200
Wheat bread — Graham	8.9	1.8	52.1	1.5	1195
Rye bread	9.0	0.6	53.2	1.5	1170
Macaroni	13.4	0.9	74.1	1.3	1625
Sugar	....	....	100	....	1750
Corn starch	....	....	90.0	....	1680
Beans, dried	22.5	1.8	59.6	3.5	1520
Peas, dried	24.6	1.0	62.0	2.9	1565
Beets	1.3	0.1	7.7	0.9	160
Cabbage	1.4	0.2	4.8	0.9	115
Squash	0.7	0.2	4.5	0.4	100
Potatoes	1.8	0.1	14.7	0.8	295
Sweet potatoes	1.4	0.6	21.9	0.9	440
Tomatoes	0.9	0.4	3.9	0.5	100
Apples	0.3	0.3	10.8	0.3	190
Bananas	0.8	0.4	14.3	0.6	260
Grapes	1.0	1.2	14.4	0.4	295
Oranges	0.6	0.1	8.5	0.4	150
Strawberries	0.9	0.6	7.0	0.6	150
Almonds	11.5	30.2	9.5	1.1	1515
Brazil nuts	8.6	33.7	3.5	2.0	1485
Chestnuts	5.2	4.5	35.4	1.1	915
Walnuts	6.9	26.6	6.8	0.6	1250

which she performs for the most part quietly and unobtrusively! It would seem to be one of the duties of the school to teach boys and girls in connection with their hygiene or general science work both to understand some of the more elementary principles of food selection and to appreciate more than they would otherwise do the care and solicitude which their mothers must exert daily in the planning and preparing of their food.

The following general suggestions concerning the planning of the family meals should be noted.

1. *Make liberal use of the cereal foods.* These will include particularly flour, meal, and cereal breakfast foods; approximately seventy-five per cent of their bulk is made up of carbohydrates, which are easily digested and form an abundant source of energy for the body. Care needs to be taken to vary the cereal foods from day to day in order to keep the members of the family — and notably the children — from tiring of them. Oatmeal is an excellent food, but served 365 mornings in the year it may easily become highly unpleasant.

2. *Use plenty of milk.* Milk is a perfect food, as we have seen. Each juvenile member of the family ought to have a quart each day, either as a beverage, on cereals, or in soups, custards, and puddings, etc. Whole milk of course is best; skimmed milk is as rich in protein and minerals, however, as is whole milk. Even at the current high prices (1925) milk is an extremely economical food.

3. *Avoid a one-sided diet.* Unless some care is exercised in the planning, it is very easy for the daily ration to provide an excess of protein and a deficiency of fuel foods, or *vice versa.* Persons who consume large amounts of meat and little vegetable foods will obviously be receiving too much protein; on the other hand, individuals consuming a diet rich in pastries, butter, and such foods will receive too little,

and an overabundance of energy-producing foods. Interesting illustrations of such one-sided diets may be seen in the case of those who live largely on bread and tea; or on corn meal, fat pork, and molasses. The 'hog and hominy' diet of the negroes in the 'black belt,' with 62 grams of protein and 3270 calories of energy per day is a case in point. Meals consisting of cereal mush served with butter and syrup are likewise deficient in protein. Similarly a school lunch consisting of bread and cake lacks building material for the body. Bread, potatoes, and rice served at a single meal yield too much carbohydrate. Baked beans, thick soups, or legumes should be served as substitutes for and not in conjunction with meat. A custard made of eggs and milk does not belong properly with a meal in which a liberal portion of meat has been served.

Sample menus. The following sample menus are suggested as being well-balanced, containing adequate portions of proteins, carbohydrates, fats, minerals, and vitamins.

1. For a Family of Five, Including Three Small Children [1]

Breakfast

Fruit, 1¼ pounds of fresh fruit (equivalent to 5 medium-sized oranges, 5 small apples, or a quart box of strawberries) or 3 or 4 ounces of dried fruits (equivalent to 10 or 12 dates or 4 or 5 figs).

Cereal breakfast food, 4 ounces before being cooked, or about 1½ pints after it is cooked. The equivalent in food value in puffed or flaked ready-to-eat cereals would be 5 or 6 cups.

Milk on cereal, ¼ cup for each person.

Sugar on fruit, on cereal, or in coffee, 2½ tablespoons, or 1¼ ounces.

Bread, 8 slices, or 8 ounces.

Butter, 1¼ ounces, or 2½ cubic inches.

An egg, or 2 ounces of meat, fish, or poultry for each older person, and a glass of milk for each young child.

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[1] See *Farmers' Bulletin*, no. 808, United States Department of Agriculture, March, 1917.

Dinner

Meat, or fish, ¼ pound per grown person; or, for each child, an egg or a glass of milk.

Potatoes, 1¼ pound (5 of medium size).

Another vegetable (turnips, corn, spinach, cauliflower, or other), 1 pound.

Bread, 8 slices, or 8 ounces.

Butter, 1¼ ounces, or 2½ cubic inches.

Steamed apple (or other fruit) pudding. (Ingredients: 2 cups flour, 2 tablespoons butter, ¾ cup milk, 4 apples, 1 tablespoon sugar.)

Sauce. (Ingredients: ½ cup sugar, 1½ tablespoons flour, 2 teaspoons butter, ¼ cup water, flavoring.)

Supper

A gravy made out of 1 pint of skimmed milk, ¼ cup flour, 2 level teaspoons butter, and 4 ounces salt, or smoked fish (just enough for a flavor). To this can be added the yolk left from the frosting of the cake. (See below.)

Rice, 8 ounces, or 1 cup, measured before being cooked.

Bread, 8 slices, or 8 ounces.

Butter, 1¼ ounces, or 2½ cubic inches.

One half of a cake. (Ingredients for whole cake: ¼ cup butter, ½ cup sugar, 1 egg, ½ cup milk, 1½ cups flour, 2½ teaspoons baking-powder.) Frosting made with 1 egg-white and ¾ cup sugar.

2. For a School Child

Breakfast

Apple sauce

Oatmeal with milk.

Milk to drink.

Dinner

Stew, with carrots, potatoes, and a little meat.

Whole wheat bread.

Creamy rice pudding.

Milk to drink.

Supper

Cream of bean soup.

Crackers and jam.

Milk.

Breakfast

Stewed prunes.

Cocoa.

Toast and butter.

Dinner

Fish, with white sauce.

Spinach or other greens.

Corn bread.

Milk to drink.

Supper

Baked potato.

Apple Betty.

Milk.

Practice economy in food selection. The careful housewife is on the alert to introduce economy into her budget for food. She is concerned constantly with the question: "What foods furnish the largest amounts of available nutriment for the least cost?" Unquestionably, the cheapest food is the one that supplies the greatest nutritional returns for the least outlay of money. Many of the more expensive foods are highly extravagant, since it is often the least expensive ones that represent the highest food value. Two pounds of beef-stew meat, for example, which can be bought for thirty cents, represent 1530 calories, while a pound and a half of loin, which would yield the same amount of nutriment, would cost well over a dollar. The market price of food materials bears no relationship to their value for nutriment. An ounce of protein from the tenderloin of beef is no more nutritious than that from a round or shoulder, but it costs twice as much.

The practice of economy in the buying of food does not of course mean that the cheapest things should always be bought. There is good reason occasionally for paying a trifle more for animal food than for the same number of calories in vegetable food. The agreeableness and appetizingness of a kind of food is an important factor, and should not be overlooked in selecting the menus. Seasonableness is another factor. What would be highly extravagant in the dietary at one season of the year might be a distinct economy at another season.

Leave coffee and tea out of the children's dietary. While many adults not only are in no way harmed by indulgence in tea and coffee, but even claim their habitual use to be distinctly beneficial to them, these beverages should not appear in the dietary of growing children. Caffein, the active principle in coffee, is a powerful stimulant, a single cup of coffee containing from two to three grains, or as much

as a full medicinal dose. The tannin in tea is more immediately stimulating to the brain than is coffee, and the ill-effects of both, when taken to excess, are observable in persons who are nervous and anæmic, or who suffer from insomnia and dyspepsia. Dr. Winslow sums up the matter well in these words:[1]

> The habitual use of tea and coffee, like that of tobacco, does not improve the health. A single cup of either taken daily will not injure perceptibly the health of most normal persons. Used to excess, and by susceptible persons, the harm done by tea and coffee is immense. The race would be better off without either, and the young should be discouraged from initiating the habit.

There are plenty of healthy beverages for us all without resorting habitually to those known to be harmful to many, and which are wholly lacking in any food value for all. Milk, water, fruit juices, and cocoa should represent the chief if not the sole beverages permitted to children, and adults would be better off if they followed the same rule. Personally, the writer has made it a practice for many years to abstain from the habitual use of coffee and tea.

✓ **Enjoy the meal hour.** Finally, there should be no pleasanter time in the whole day than that when the family is gathered about the table. Good spirits, companionable enjoyment, and a general attitude of cheerfulness should prevail. Emotional experiences of an overexciting or of a depressing nature should be eliminated. Too many families seize the dinner hour as an excellent opportunity to air their grievances with one another, or with some neighbor, or with the world in general, thus producing in the minds of all tenseness, unhappiness, and even anger. These unfortunate emotional states have a most pronounced effect upon digestion, checking in considerable measure the secretions, and thus slowing down or quite inhibiting the whole process.

[1] Winslow, K: *The Prevention of Disease in the Individual*, p. 21. W. B. Saunders Company, Publishers.

TEACHING POINTS IN THIS LESSON

A. Structure and Function

1. The salivary glands.
2. The structure of a tooth.
3. Digestion of food in the stomach.
4. The shape, size, and function of the small intestine.
5. The relationship of the liver and pancreas to digestion.
6. The absorption of food.
7. The nature of metabolism.
8. The excretory organs of the body.

B. Hygiene

1. The practical importance of good digestion.
2. The threefold function of food.
3. The relationship of occupation, age, season, and personal body chemistry to the dietary.
4. Carbohydrate foods, their contribution and source.
5. Fats in the diet.
6. The importance and chief sources of proteins in the diet.
7. The chief sources of the vitamins, and their importance.
8. Fuel values and caloric needs at various age levels.
9. Importance of a balanced diet.
10. Tea and coffee.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Prepare a digestion chart, showing the chief transformations which proteins, fats, and carbohydrates undergo in the mouth, stomach, and intestine, and by what secretions these several transformations are wrought.
2. Write a brief paper on the subject: "Outraging One's Own Digestion."
3. Prepare a food chart, classifying under the headings "Proteins," "Carbohydrates," "Fats," "Minerals," and "Vitamins," as many foods as you can find the analysis of. Place nearest the top in each column those foods richest in the particular element designated.
4. Study the dietaries of the Eskimos, the Filipinos, and the Central Europeans. What notable differences do you discover that can be attributed to climatic needs and regional opportunities?
5. Show that the typical dietary of a Chinese, an Italian, and an Irishman — each in his native habitat — may be equally satisfactory.
6. Arrange a satisfactory 24-hour menu for a school child of ten years; for his father, who is a truckman; for his mother; for his elder brother, who is a student in college; for his sister, who is a typist.
7. Make a list of ten common-sense rules about the diet.

SELECTED REFERENCES

1. Emerson, W. R. P. *Nutrition and Growth in Children*, chap. 11.
2. Lee, R. I. *Health and Disease: Their Determining Factors*, chap. 2.
3. Stiles, P. G. *Nutritional Physiology*. (General Reference.)
4. Terman, L. M. *The Hygiene of the School Child*, chap. 8.

CHAPTER X

THE MAJOR SENSES

I. VISION

1. *Structural approach*

General sensations and special senses. If one tries to analyze such diffuse sensations as are experienced during indigestion, hunger, and the like, he soon reaches the conclusion that these are not definitely localized at certain specific points in the organism, but rather seem to be felt in a general way throughout considerable areas of the body. To such indefinitely localized experiences as these, the term *general sensations* is commonly applied. Others besides indigestion and hunger would include thirst, nausea, dizziness, ennui, indisposition, 'laziness,' fatigue, etc., inasmuch as none of these may be said to originate in definite sense organs specifically designed to transmit them into consciousness.

Quite different from these general sensations, however, are those specific, sharply defined, and invariable functions, like vision and audition, which are subtended by highly specialized end organs designed exclusively by Nature to translate external stimuli from the world outside the body into nerve impulses which, when registered in the brain, arouse clear-cut impressions that faithfully reflect the external world of matter. To the organs subtending this function, the terms *sense organs*, *end organs*, and *receptors* are synonymously applied. The eye, the ear, the nostril, the tongue, and the skin fall within this classification. The first of these, the eye, can work only with light and color waves; the second, the ear, can transmit only sound waves; the nostrils are re-

ceptive only to volatile particles possessing odorous properties; the taste buds on the tongue can respond only to the taste qualities — sweet, sour, bitter, and salt; the skin, equipped as it is with several specific types of nerve structures, can register sensations of heat and cold, and of pressure and pain. Each receptor may be said to have only its own *adequate stimulus*: for the eye, the adequate stimuli are ether waves; for the ear, sound waves, etc. Light waves are inadequate stimuli for the end organ of hearing, as are sound waves for the end organ of seeing, etc.

All our knowledge is ultimately dependent upon the experience we have had with people and objects external to ourselves. The amœba and the paramecium, having only the most rudimentary general structure, can absorb no experience, and hence can assemble no knowledge. Human beings born blind are severely handicapped; those born both blind and deaf are doomed in most cases to remain infants in intellect. Between those who have become blind and deaf by disease or accident, yet who once saw and heard, and those congenitally blind and deaf, fate has reared an impassible barrier.

Since they are the two most important senses, as well as the ones of particular significance for educational hygiene, we shall limit ourselves in the present work to a study and discussion of the major senses of vision and audition. This chapter will be concerned with the former of these; the next will be devoted to the latter.

Structure of the eyeball.[1] The eyeball, commonly spoken of as the 'eye,' is a spheroid body about one inch thick, and a trifle longer in its anterior-posterior than in its vertical diameter. It is fitted loosely into a socket of the cranium

[1] It will add considerable vividness to the study of the eye if the student will secure at the market the eye of an ox or sheep, and will dissect it carefully, identifying each of the structures mentioned or described in the text.

and supplied with muscles which enable it to be moved freely in several directions. Structurally, the eyeball is comprised of three coats, within which are enclosed transparent media that permit the passage of light waves through to the back of the ball. The first of these coverings is called the *sclerotic*, and is made up of very tough connective tissue. Its function is to protect the very delicate mechanism beneath, and to serve as the point of attachment for the eye muscles. Directly in front, in the region of the iris, the sclerotic becomes transparent, forming the *cornea*, which curves outward convexly from the sclerotic proper. By this means light rays are permitted to pass unchecked into the interior of the ball. Just underneath the tough sclerotic is a second coat, the *choroid;* this is a black, opaque layer which effectively prevents light rays from entering the eyeball except at the front. Here, instead of becoming transparent, as the sclerotic does, the choroid draws back from the sclerotic to form the *iris*. A second function performed by the choroid, in addition to rendering the eye-camera opaque, is a nutritive one, the meshes of its tissue being richly supplied with blood vessels which furnish the eye mechanism its necessary quota of food and energy.

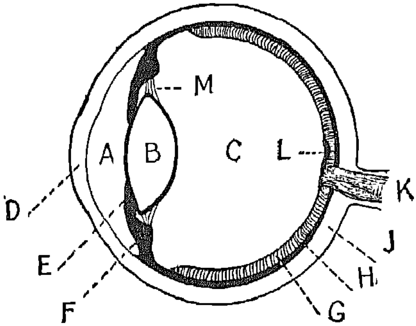


FIG. 53

Diagram to show the chief structures of the eyeball. *A*, aqueous humor; *B*, crystalline lens; *C*, vitreous body; *D*, cornea; *E*, iris; *F*, ciliary muscle; *G*, retina; *H*, choroid coat; *J*, sclerotic coat; *K*, optic nerve; *L*, macula lutea, or yellow spot; *M*, suspensory ligaments.

Over a considerable part of the visible outer area of the

eyeball the sclerotic is seen as the 'white of the eye.' Set beautifully in the center of this visible area is the iris, or colored portion of the eye, formed, as mentioned above, by the choroid, which draws away from the sclerotic in this region, presenting the appearance of a circular disc of color — blue, gray, brown, or some other hue. There is no pigment in the iris of the Albino, and through it may be seen the pinkish reflection of the blood in the choroid beneath. The iris is punctured exactly in the center by a black aperture: the *pupil*, through which all light waves entering the eye must pass. You have no doubt observed the diurnal variations in the diameter of the pupillary doorway into the eye. When it is very bright, as at midday or in an intense glare, the pupil becomes very small; when there are few light waves, as at twilight and dusk, its diameter is considerably increased in order to admit to the eye all the feeble rays possible. Were the very delicate retina of the eye not thus protected from too strong rays of light, it would be irreparably injured, if not actually destroyed, by their admission.

The third and most delicate of all the coats is known as the *retina*, which lines the interior of the eye throughout three fourths of its extent. Structurally the retina consists of a thin layer of nervous tissue spread over the choroid from the upper ciliary body around posteriorly to the lower one. It is in reality a film of specialized structure which represents the peripheral terminus of the optic nerve. This nerve, breaking through the posterior wall of the eyeball, passes through the sclerotic and choroid and at once frays out to form the retina. Anatomists have been able to make out ten distinct layers in the retina, the most important of which are the *rods* and *cones*, so named from their appearance under the microscope. The latter of these, the cones, are believed to be the essential elements in acute visual perception,

since they are found exclusively at the 'yellow spot.' The *yellow spot*, or *macula lutea*, is a slight depression in the retinal sheet, just above the point of entry of the optic nerve, and it is upon this that the converging rays from external objects must come to a focus in order to be perceived clearly and sharply. The *blind spot* is a term often applied to that region of the retina where the optic nerve enters the eye. At this point there is no vision, as may be readily demonstrated by means of the experiment suggested in connection with Figure 54.

FIG. 54. A TEST FOR THE BLIND SPOT

Holding the book at the customary reading distance, close the left eye and fixate with the right eye the circle at the left. Draw the book slowly toward you until you find a place where the circle at the right disappears. Do the same with the right eye closed. By drawing the book still nearer, the star in the center may be made to disappear likewise.

Study of the diagram of the eye (Figure 53) will indicate the fact above referred to that the cornea arches outward convexly from the sclerotic, giving the impression of a pronounced bulge in the anterior region of the eye. The convexity of this arch is preserved from within the eye by the pressure upon it of the *aqueous humor*, which is a transparent, water-like fluid, possessing, like the cornea itself, some minor refracting qualities. The outward arch of the cornea may be readily noted if you will look from the side across the eyes of some one who is gazing straight ahead. The anterior chamber of the eye is completely filled with the aqueous humor. In a similar way, the main body of the eye, posterior to the lens, is filled with a liquid called the *vitreous humor*, or *vitreous body*, which is a transparent, gelatinous mass. The vitreous body fills out the rotundity of the eyeball, holds the retina lightly against the choroid, and forms anteriorly a basin-like depression in which the lens fits easily.

Suspended from the ciliary bodies by *suspensory ligaments* is the *crystalline lens*, whose function it is to refract all light rays passing through it so that clear images may be imparted to the retina. The lens bears the same relationship to the retina that the camera lens bears to the plate or film, as we shall see. It is a bi-convex lens, but possesses the peculiar capacity of increasing or decreasing readily its convexity according to the nature of the light waves that fall upon it from without.

If you have ever been obliged to remove a foreign body — such as a speck of dirt or dust — from your eye, you have made the discovery that the inner lining of the eyelid turns back over the front part of the eyeball itself. This very thin, delicate membrane is known as the *conjunctiva*. It is very sleek and smooth so that no friction may be offered to the rotation of the globe in its socket. Since, however, both the conjunctiva and the exterior surface of the eyeball are continually in working contact, Nature is compelled to supply a constant and liberal lubrication. This is accomplished principally by means of the tears secreted by the *lachrymal gland*. This very important part of the visual apparatus is about the size of a filbert, and lies in the outer and upper part of the orbit above the globe. The secretion is discharged over the upper surface of the eyeball through ducts, and after passing down over the conjunctiva it is taken up by two small ducts at the nasal side of the eye and by them carried into the *tear sac*, which empties into the nose through the

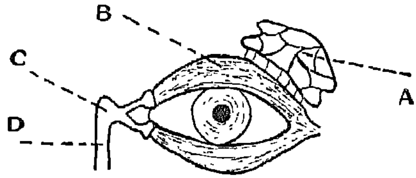


FIG. 55. THE LACHRYMAL APPARATUS
A, lachrymal gland; *B*, upper eyelid; *C*, lachrymal sac; *D*, naso-lachrymal duct.

naso-lachrymal duct. This explains the common involvement of the eye when one has a cold or other nasal infection.

The mechanics of the visual act. In understanding the physiology of the visual act, it will be helpful to use the analogy of the camera. As every one knows, the essential parts of a camera are a lens, properly protected by a shutter, a sensitive plate or film, and a focusing mechanism. But there is one striking difference between the eye-camera and the photographic camera. The latter must be laboriously set up, aimed, and focused by an expert operator in order to produce a clear image. The lens is helpless to adjust its convexity to the parallel rays of light proceeding from a distant object or to the divergent rays proceeding from a near object. The operator must therefore increase the distance between the lens and the plate for near objects, and diminish it for distant objects. The normal human eye, however, operates automatically. There is no 'setting up,' no elongation of anterior-posterior diameter, and the idiot gets no poorer immediate results from its operation than does the genius. Without question the supreme marvel of the human eye is the lens. Let us study its operation and structure somewhat more in detail, pausing first to recall two or three known facts concerning rays of light and the physics of lenses.

The movement of light rays. There are two sources whence light may reach the eye: luminous and non-luminous objects. The sun, an arc-light, and a conflagration, are representative of the former, since the light rays thrown out from these sources are self-generated; a house, a landscape, a printed page are representative of the latter, since these bodies generate no rays of their own but merely reflect the rays back that are thrown against them by some luminous body. Is the moon a luminous or a non-luminous body? Regardless of whether or not the immediate source of the

light rays which impinge upon the eye be a luminous or non-luminous object, the rays themselves are known to be traveling at a terrific rate, and, except the object be very close, in straight paths parallel to one another.

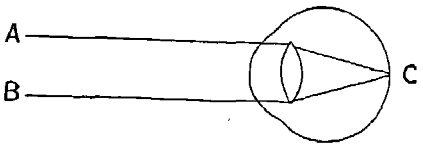


FIG. 56

Illustrating the converging of parallel rays of light upon the retina. *AB*, parallel rays of light from a distant object; *C*, point of exact focus on the retina.

Figure 56 illustrates the parallelism of light rays reflected from a distant body.

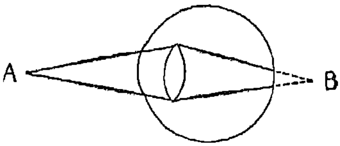


FIG. 57

Illustrating the divergent rays from a near object. Divergent rays emanating from *A* cannot be converged exactly on the retina without ciliary effort; rather they cut the retina at innumerable points, and would focus behind it at *B*.

When, however, the object whence the luminous rays are reflected or originated is within fifteen feet or less of the eye, as must ordinarily be the case when one is reading a printed page, or looking at any object across a small room, the rays that enter the eye are no longer traveling in parallel paths, but are divergent, i.e., scattering, and the nearer the object is brought to the eye the more divergent become its reflected rays. Figure 57 illustrates the divergency of luminous rays reflected or emanating from a near object. This peculiar circumstance necessitates

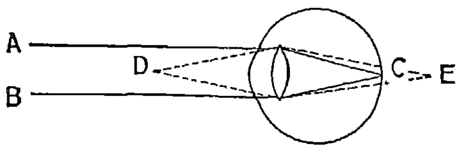


FIG. 58

Diagram to illustrate the reception of parallel and divergent rays of light in the emmetropic eye. Parallel rays, *AB*, from a distant object, focus without ciliary effort at *C*; divergent rays from object *D*, which without accommodation would focus at *E*, are made to focus in the emmetropic eye at *C* by accommodative effort.

both the 'focusing' of the camera and the 'accommodation' of the crystalline lens, for it is obvious, as Figure 58 will illustrate, that the more divergent the rays entering the pupils the more they must be bent by the lens in order to be converged to a point upon the retinal plate.

Some relevant properties of lenses. Figure 59 represents two ordinary glass lenses of the bi-convex type. The diameter of M is less than the diameter of N. If now parallel rays of light are passed downward in the direction of the arrow it will be found that they will be bent to a point much more slowly by lens M than by lens N. The principle here involved is the well-known law of physics, which states that the flatter a lens the more tardily are light rays passing through it refracted, and conversely, the more spherical the lens the more swiftly are rays passing through it refracted.

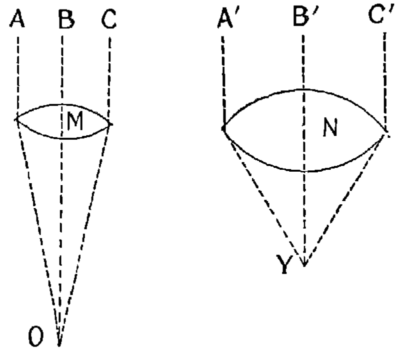


FIG. 59. TWO BICONVEX LENSES

ABC, light rays passing downward through lens M; $A'B'C'$, similar parallel rays passing downward through lens N. Note that the thinner lens converges the rays more tardily than does the thicker lens.

Figure 60 represents some typical lenses. A is a bi-convex lens, i.e., a glass both sides of which are convex, thus being thicker in the central portion than at the edges; B is a bi-concave lens, i.e., a glass both sides of which are concave, and thus thicker at the edges than in the central region. Parallel rays of light passing through C will be converged sooner or later, depending upon the amount of convexity; rays passing through D will be diverged and can never meet,

and the rate of their divergence will be dependent upon the amount of concavity of the lens. A strong lens is differentiated from a weak lens by the fact that its curvature is greater, thus bending rays more sharply. This property

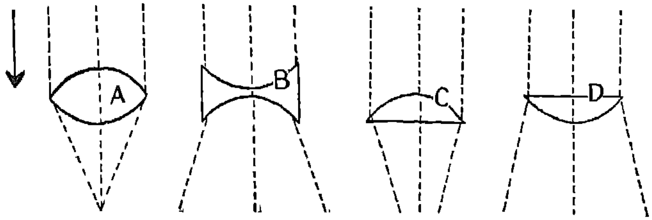


FIG. 60
Illustrating several types of lenses. *A*, double convex lens; *B*, double concave lens; *C*, planoconvex lens; *D*, plano-concave lens.

of bending parallel or divergent rays of light as they pass through a lens or prism is known as *refraction.*

The lens the principal refracting surface of the eye. Bearing in mind these two principles: (1) the fact that rays entering the eye are either parallel or actually divergent, and (2) that the amount of refraction which they undergo is dependent necessarily upon the thickness or thinness of the lens anterior-posteriorly, we are now in a position to analyze the ocular phenomenon of *accommodation.* Try the following experiment. Fixate a definite point ten or twelve feet away: e.g., a detail in the wallpaper, a small ornament on the mantle, etc. While gazing intently and actively at the point selected, pass slowly across the field of vision an open book held at arm's length from the eyes. Be particularly careful not to let your fixation adjustment to the distant object be altered, even after the printed page is directly in front of your eyes. Now carefully take in passively the general appearance of the page. Can you make out any of the detail? What do you find it necessary to do before the print 'clears up'?

Try another experiment. Hold a pin upright between the thumb and finger at arm's length, regarding it fixedly. Draw it slowly toward your eyes, maintaining the fixation. Try to 'feel' what goes on inside the eyes as the pin is brought very close to the nose. At about what distance does it cease to appear a single pin, and become double? Let a classmate perform this experiment. Stand at her side and note any change in the prominence of the cornea that may be manifested as the pin is brought closer to the experimenter's eyes. Can you venture an explanation of what you see?

As we stated above, the length of the eye chamber cannot be altered, as can the distance between the lens and the plate of the camera. The only possible adjustment that can be made to the increasingly divergent luminous rays entering the pupils as the pin is drawn nearer to them lies in the thickening of the lens. While the eyes were fixated upon the wallpaper detail or ornament some distance away, the lens remained relatively thin and flat. When the printed page was interposed, the lens must adjust itself to the divergent rays reflected from it by becoming thicker.

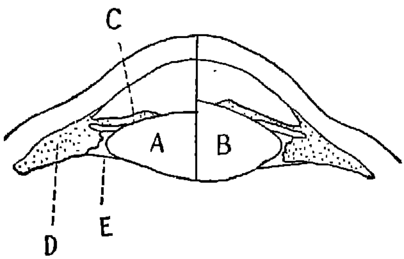


FIG. 61

Diagram to illustrate accommodation. *A*, position of lens at rest or adapted to far vision; *B*, condition of the lens when adjusted for near vision; *C*, iris; *D*, ciliary muscle; *E*, suspensory ligaments.

This change in the diameter of the lens is shown clearly in Figure 61, *A* representing the condition of the lens during adjustment for a distant object, and *B* representing its condition when adjusted for a near object.

As stated above, the lens is held suspended vertically between the aqueous and vitreous humors by the suspensory ligaments, which originate in the ciliary bodies, the terminations of the choroid at its anterior extremities. The *ciliary muscle* comprises an important part of the ciliary body. It is a circular band, having the function under contraction of drawing the anterior surface of the lens forward and so increasing the thickness of the lens. The feeling of strain in the eye when the pin was brought close to it in the experiment above is caused in part by the contraction of the ciliary muscles, which are endeavoring to increase the convexity of the lens to refract the rays from the approaching object so that they may be converged upon the retina. Only after the pin has been brought very close do the luminous rays reflected from it become too divergent for the lens to refract them sharply and clearly and converge them upon the retina. To this property of the eye mechanism, through the activity of the ciliary muscles to adjust to the distance of an object within the range of the visual field, so that it is seen plainly and without blur, is applied the term *accommodation.*

An illustration will indicate how continuous and severe the work performed by the ciliary muscles really is, although their control is so perfect and their performance so efficient in the normal eye that we are rarely aware of the strain placed upon them. Suppose one is reading a printed page in a book at the ordinary reading distance. As the eye traverses a line from left to right the lens must continually change its convexity, for the letters and words at the beginning of the line are not the same distance from the eye as are those in the middle of the line, and those in the middle of the line are not the same distance away as are those at the end of it. Indeed, it is probable that very few of the letters are equidistant from the eye. It is obvious, of course, that no letter or letter-group can form a sharp impression upon

the retina unless the light rays reflected from it are accurately bent, and, as we have already seen, the convexity of the lens must be increased for the nearer objects and diminished for the more distant. Even so slight differences in the distance of objects from the eyes as exist between the letters and words in a printed line, must be accommodated to by the action of the ciliary muscles modifying the convexity of the lens. Thus, a word at the beginning and at the end of a line, assuming the book to lie directly in front of one, is several millimeters further from the eye than a word in the middle of the line. Consequently, in the proper refraction of the rays entering the eye as it moves across a single line, the lens must become slightly more convex as the eye approaches the center, and must then immediately become slightly less convex as it proceeds toward the right-hand end. Think of the uncounted thousands of minute adjustments the lenses must make during a half-hour's reading! And then think of the added thousands they must make in the course of a day's work in the office, factory, school, etc.! Is it any wonder that, even with the most sensible care, our eyes sometimes protest at the amount of near work we require of them, and cause headache, nervousness, eye-strain, and all the other difficulties attendant upon excessive accommodation demanded of the eye mechanism?

The external muscles of the eye. In addition to the mechanism of accommodation resident in the ciliary muscles and lens, the eyes have another elaborate muscular mechanism which enables us to fixate the same object with both eyes. This apparatus consists of six pairs of muscles attached externally to the sclerotic coat at one end, and to the bony orbit at the other. The corresponding muscles of both eyes normally work in perfect harmony with one another, so that when one eye is turned to the right or left, or up or down, or obliquely, the other is turned correspondingly.

The axes of both eyes are, in other words, always parallel. Were this not true, as we shall see later in our discussion of strabismus, or cross-eye, two separate impressions would be registered on the two retinæ, one from the right and the other from the left eye. By the marvelous niceness of their correlation, however, both eyes always focus on the same object, and we receive a single tri-dimensional impression.

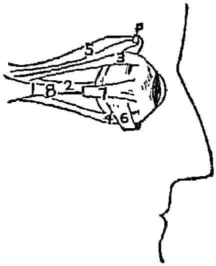


FIG. 62. MUSCLES OF THE EYE

By courtesy of the Eye Sight Conservation Council of America.

Figure 62 represents the attachment of the six oculomotor muscles upon the eyeball. It will be noted that each of them is attached to the orb near its equator in a manner which makes it easy to turn the ball in any direction. The one attached to the top of the orb is called the *superior rectus* muscle, and turns the eye upward; antagonistically attached to the bottom of the orb is the *inferior rectus*, which turns it downward; the muscle attached to the outer side is termed the *external rectus*, and rotates the eye outward; its antagonist on the nasal side is the *internal rectus*, which rotates it inward. The two remaining muscles — the first of which, in order to exert better purchase upon the ball, passes through a pulley fastened to the nasal side of the orbit — are the *superior oblique* and *inferior oblique* muscles, both of which are concerned in turning the eyes diagonally or obliquely in their sockets. Why are the superior and inferior recti said to be antagonistic? Can you think of ocular situations in which two or more of the six muscles in either eye are reacting simultaneously and in a complementary manner?

Tri-dimensional, or binocular vision. Try the following simple experiment. Seat yourself three feet from and facing

the wall. Push a thumbtack into the wall immediately in front of you and on a level with your eyes. Raise your right forefinger sidewise to a point in the line between your nose and the tack, preferably within ten or twelve inches of your nose. Now close your left eye and right eye alternately. You will note that when the left eye is closed your finger appears to jump to the left, and that when the right eye is closed it seems to jump to the right. You will note also that when the left eye is closed you can see about half of the finger-nail, but that when the right one is closed the nail virtually disappears. The front side of the finger nearest you is seen by either eye, but the left side can be seen only with the left eye and the right side can be seen only with the right eye.

Figure 63 is a sketch to indicate roughly the binocular field of vision, illustrated by the above experiment. From a study of it you will note that, while there is a common region (*C*) visible to both eyes, there are marginal regions (*A*) and (*B*), which are visible to but one, (*B*) to the right eye and (*A*) to the left eye. In other words, both eyes do not see exactly the same thing.

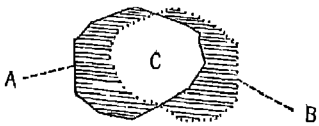


Fig. 63

Diagram to illustrate the binocular field of vision. (*After Moser.*) *A*, boundary of the field seen by the left eye; *B*, boundary of the field seen by the right eye; *C*, area common to both eyes.

Try another experiment. Examine carefully the two photographs on an ordinary stereoscopic slide. Is more of the left side of the scene visible in the right-hand picture? Is more of the right side of it visible in the right-hand picture? Look critically at one of the pictures; does it appear flat, as it actually is, or do you get a sharp suggestion of depth? That is, do the things in the foreground appear actually to be tri-dimensional, or do they seem merely to be a part of

the total flat effect? Place the card in the stereoscope and examine it critically again. Does it now appear flat? Do objects in the foreground actually appear to 'stand out' with solidity from objects farther in the background? What is the explanation?

When the stereoscope card is made there is something more to it than simply developing the same print twice and pasting one on each half of the card. The photographer must actually take two exposures of the scene or object to be depicted, one with the camera at one place, and the other with the camera set a few feet to the left or right. The reason is an obvious one: the left eye does not see exactly the same thing that the right eye does, but sees around somewhat to the left; similarly, the right eye 'sees around' somewhat to the right. Now if both images on the card were identical, placing the card in the stereoscope would fail to bring out the depth idea when they fused, but would present to us only a flat picture. Instead, a stereoscopic view always gives the illusion of depth, since each eye is presented with a miniature of the exact thing it sees when looking at the original object.

If you will test out the principles brought out in the above illustrations a bit — for example, by looking across and around the room with one eye closed, and then with both eyes open, or looking across a landscape or down a city street in the same way — you will appreciate the extreme practical value of binocular vision in helping one to judge distance, size, perspective, and the like. In what several ways is an individual handicapped who has been deprived of the sight of one eye?

2. *The hygiene of vision*

The eyes of primitives, children, and elderly adults. It will be interesting at this point to compare the eyes of

primitives with those of civilized children and adults. The nature of the habitat in which peoples low in the scale of culture live is tremendously different in one respect from that in which highly civilized people at the other end of the culture scale live. The conditions under which the former exist make relatively no demands upon the eye for near or for very fine work. There are no schools, with their myriads of printed volumes to be read and mastered; there is no written language to be studied and practiced as an art; there are no offices, with their typewriters and short-hand systems; there are no factories, where men and women must sit for eight or more hours a day — for example watching for flaws in the weave of a continuous web of cloth coming through the loom; there are no newspapers, or magazines, or libraries, with their store of books to be read in daylight, in twilight, by candle-light, or under the rays of an electric bulb. What primitive men are concerned largely about are the flight of prey in the forest, the thin trail of smoke on the horizon, and such other situations as may be portentous for them. The strain of civilization has not yet reached their ciliary muscles!

All this merely means that primitive peoples — children of Nature, as they are — use their eyes primarily for distant or semi-distant vision. It is relatively rarely that they must keep their eyes focused for a considerable period upon fine objects within eighteen inches of their eyes, as we must do whenever we read, or write, or do fine handwork. At most, about all the work that the lenses in the eyes of uncivilized people are called upon to perform consists in bending parallel luminous rays, while the major portion of the work performed by the lenses in the eyes of civilized people consists in refracting divergent rays emanating from surfaces nearer to the eyes than fifteen feet. As we already know, the former places no strain on the ciliary muscles, since there is

sufficient convexity in the normal lens to refract parallel rays without their contraction; the latter, on the other hand, can only be accomplished by the pressure brought to bear upon the lens by them.

The most typical condition of adjustment for the primitive eye is, then, that for far vision, which implies complete relaxation of the ciliary muscles. It has not apparently been Nature's intent, up to this time, that the eyes of her child should be *naturally* adjusted to near vision. She evidently did not foresee when she evolved the ocular mechanism what was to take place after the invention of printing and the advent of the industrial era, and it has been only at the expense of no little suffering and inconvenience that civilized man has been able to adjust his eyes even imperfectly to the new strain placed upon them.

Since ciliary relaxation and consequent adjustment for far vision was the typical condition of the eyes of primitives, the same is the natural condition for the eyes of young children, who are nearer the primitive type in their general structure than they are to any civilized type. This is but another way of saying that the eyes of children are naturally and normally far-sighted. Careful teachers and guardians of childhood take great pains to prevent overtaxing of the ciliary muscles during the early years of school life, while the ocular lenses are thin and flat, and can only refract the rays from near objects by abnormal contraction of the ciliary muscles. Thus, we provide primary children with large print and large pencils, and require of them the minimum of fine work; we do not confine them for long periods at their desks, but expect and permit them to move about somewhat freely, and to learn chiefly through the spoken word, the story, the blackboard, and through such activities as allow them more or less freedom and necessitate the minimum of ocular fixation upon close work at the desk. Gradually, as

the child passes upward through the grades, by dint of more or less steady exercise, the ciliary muscles become more sturdy, and the lenses under their pressure assume the normal convexity characteristic of the eyes of youth and early adulthood.

By virtue of the fact that the crystalline lens has a tendency to lose its elasticity and become somewhat hardened in the course of a lifetime, it very commonly happens that somewhere around the age of forty-five, there develops a distinct loss in ability to accommodate the eyes to near vision. At such a time, it is not unusual to behold the spectacle of a middle-aged person holding a book or paper at an abnormal distance, or indeed adjusting his glasses before even making an attempt to read. This loss of accommodative power in middle life is known as *presbyopia.* Thus does the elderly man revert naturally to the far vision of his childhood, with the difference, however, that now he cannot accommodate to near objects without glasses, whereas then he could and did so accommodate to an ever-increasing degree.

Emmetropia, or normal vision. Due to innate diversities of structure the eyes of different individuals are found to differ quite perceptibly in their axial length, i.e., in the length of their anterior-posterior diameter. There are three possibilities in this connection; viz.: (1) the length of the ball is approximately normal, i.e., somewhere in the very near vicinity of 24 mm.; (2) the ball may be too short; i.e., its axis is somewhere between 21 mm. and 24 mm.; or (3) the ball may be too long; i.e., its axis is somewhere between 24 mm. and 27 mm. To the first of these three types of eye is applied the term *emmetropia.* The emmetropic eye may be defined as an eye which converges without ciliary contraction the parallel rays of light entering it from a distant object (farther away than fifteen or twenty feet) exactly upon the retina. Obviously if the eye were too long or too short,

such rays could not be converged at the *macula* except by means of a glass, or by the action of the accommodative muscles. In the emmetropic eye, in other words, the natural convexity of the lens, with the muscles relaxed and at rest, is just right to bend the parallel rays to a focus directly upon the retina. Figure 64 illustrates the emmetropic eye.

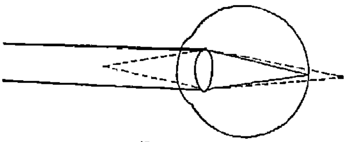


Fig. 64
Diagram to illustrate the emmetropic eye.

Now, since the luminous rays from objects nearer than fifteen feet are known to be divergent, it is apparent that when the emmetropic eye fixates such an object the rays will fall upon the lens at a slight angle, instead of being parallel. The lens, in order to refract them to the same point, must increase its diameter through the contraction of the ciliary muscle. Otherwise they would not meet but would strike the retina at various points and produce a blurred image. The dotted lines in Figure 64 are drawn in to indicate the path which divergent rays from near objects would follow if the lens were to remain inactive. The normal, emmetropic eye, then, undergoes no strain in refracting rays from distant objects, but can only adjust to near objects through the action of the accommodation muscles. Needless to say, this accommodatory activity in the emmetropic eye is accomplished without strain, injury, or discomfort, as long as the lens retains its resiliency, i.e., until middle life, or beyond. It is this circumstance which justifies the application of the term 'emmetropia' to normal eyes.

Hyperopia, or far-sightedness. As stated above, through hereditary structure some eyes are too short in their anterior-posterior diameter, so that parallel rays of light even from distant objects do not converge at the retina without ciliary

action. To this ocular defect, due to a too short anterior-posterior diameter of the globes, the term *hyperopia*, 'far-sight,' is applied. Figure 65 illustrates the condition of the hyperopic eye. In the emmetropic eye, as we saw, the cili-

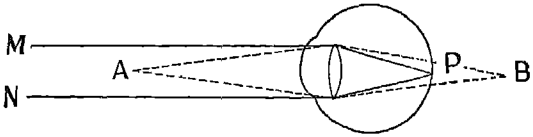


FIG. 65

Diagram to illustrate hyperopia. Parallel rays of light, *MN*, from a distant object are focused without effort at *P*; diverging rays of light, as from *A*, cannot be converged sufficiently by the lens to bring them to a focus.

ary muscle is relaxed in distant vision, the natural convexity of the lens being sufficient to bend the rays to a focus at the retina; in the hyperopic eye, however, due to its axial shortness, the accommodation muscles must thicken the lens even in distant vision, since the eye is too shallow to allow them to focus passively. The more far-sighted the eye is, i.e., the shorter its axial diameter, the greater is the burden necessarily placed upon the accommodation muscles. It is apparent that the hyperopic eye is severely handicapped in near vision, since still greater effort must be expanded to refract the divergent rays from near objects than the parallel rays from distant objects. In fact, the far-sighted person, unless the refractive error is very slight, cannot experience clear vision in near work without the aid of glasses. The likelihood of straining the eyes if they are called upon continually to accommodate to near work is therefore extremely great in the case of hyperopia.

Correction of hyperopia by eyeglasses is a very simple process. All that is required is for the oculist to determine by measurement the precise amount of error in refraction, and then prescribe a glass having a convexity sufficient to

eliminate the error. With glasses of this sort superimposed in front of the eyes, the rays of light, instead of being parallel when they enter the eye are already converged by as much as the degree of the error. Passing thence through the crystalline lens, they are bent without ciliary effort exactly to a focus on the macula, as Figure 66 indicates. Since the ciliary muscles in the hyperopic eye are likely to be overdeveloped and hypertrophied, thus making it impossible for the oculist to measure the exact condition of the lens, unmodified by ciliary action, oculists often introduce into the eye some cycloplegic drug—notably homatropin—which has the effect of paralyzing the muscles, thus causing them to relax any accommodational pull which they may be maintaining upon the lens, and enabling the expert to determine the exact amount of refractive error in the eye. Cycloplegics also paralyze the iris, causing it to relax and thus enlarge the pupillary opening. Why cannot one read during the period in which the drug is effective? Why should strong rays of light not be permitted to enter the eyes during this time?

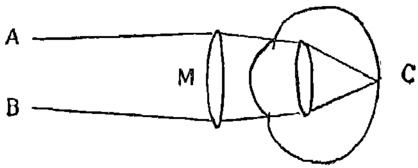


FIG. 66

Illustrating the correction of hyperopia by a convex lens. The diverging rays, AB, from a near object are bent by the convex glass, M, just enough for the crystalline lens to converge them at C without ciliary effort.

Myopia, or near-sightedness. Just as, through hereditary influences, some eyes are too short in their anterior-posterior diameters, so it frequently happens, and from the same cause, that eyes are found to possess too long an anterior-posterior diameter. In such condition parallel rays of light are converged before they reach the retina, crossing one another at a point a millimeter or so in front of it, and striking it therefore immediately after in a large number of

places, producing a blurred image. To this ocular defect, due to the excessive length of the eyeball, the term *myopia*, 'near-sightedness,' is applied. Figure 67 illustrates the condition of the myopic eye. In the emmetropic eye, as we saw, the ciliary muscle is relaxed in distant vision; in the hyperopic eye, by excessive accommodative contraction, it can converge these rays, at least during growth and up to middle age; in the myopic eye, however, it is obvious that attempts to accommodate on the part of the ciliary muscles can but make matters worse instead of better, for increasing the convexity of the lens results in refracting the rays more sharply and thus bringing them into convergence still further from the retina.

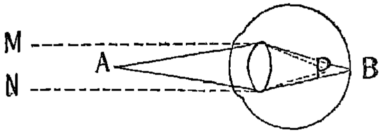


Fig. 67

Diagram to illustrate myopia. Divergent rays of light, as from *A*, focus upon the retina at *B* without ciliary effort. Parallel rays of light, *MN*, however, are bent too sharply by the lens and are brought to a focus at *P*.

When it comes to near objects, however, the myope may have excellent vision, for some divergent rays are refracted reflexly without ciliary effort, while others may be so refracted through action of the accommodation mechanism. In case the myopia is or becomes so great that objects have to be brought within three or four inches of the eye, or nearer — as often happens — the strain placed upon the external recti muscles becomes too great and binocular vision is no longer possible. In such event the myope can use but one eye at a time comfortably. This accounts for the fact that strabismus often goes with myopia.

Myopia is practically never found in children below the ninth or tenth year. At that time, however, due to the fact that the skull is assuming its truly hereditary shape, or that normally emmetropic or hyperopic eyes have been over-

strained by persistent use upon near work, myopia quite frequently makes its appearance. In other cases it does not occur until considerably later. Inasmuch as, once the eyes become definitely myopic, the defect has a strong tendency to become progressive, it comes about that at the time when presbyopia makes its appearance in the normal emmetropic eye the vision of the myope for very near work is excellent, and he is able often to read perfectly without glasses. This has led to the common superstition that near-sighted eyes grow stronger with age, which is of course untrue.

The correction of myopia by eyeglasses is as simple — in theory at least — as is that of hyperopia. Having determined the exact amount of refractive error, the oculist has but to prescribe a lens having a concavity sufficient to eliminate the error. By means of glasses of this sort superimposed in front of the eyes, the rays of light instead of being parallel when they enter the eye are divergent by as much as the amount of the error. Passing thence through the crystalline lens, they are bent without ciliary effort exactly to a focus on the macula, as Figure 68 indicates. Since the ciliary muscles are likely to exert pressure upon the crystalline lens during the examination, thus making it impossible for the oculist to determine accurately the exact condition of the lens, as we found to be the case also in the hyperopic eye, a cycloplegic is commonly employed to paralyze the muscles and permit exact measurement of the refractive error.

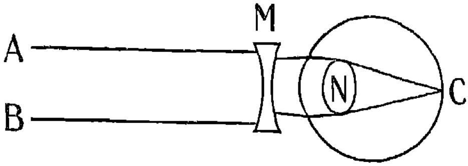


FIG. 68

Illustrating the correction of myopia by a concave lens. The parallel rays, *AB*, from a distant object, are made sufficiently divergent by the glass, *M*, to permit their exact focus by the lens at *C*.

Astigmatism. In order for a lens to converge upon the same point all rays passing through it, its curvature must be absolutely even and regular. An eye in which there is an irregularity of curvature in either of its refracting media — the cornea and the lens — is said to be *astigmatic*. A rough approximation of the structure of the crystalline lens in an astigmatic eye may be had by likening it to the shape of an ordinary hen's egg. As everybody knows, the line drawn around the shorter circumference has quite a different curvature from one drawn around the longer one. Figure 69 illustrates these two curvatures.

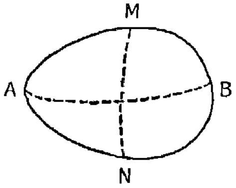


FIG. 69. THE "EGG" ILLUSTRATION OF ASTIGMATISM

The curvatures in the two meridians are obviously different.

Now if you will visualize a crystalline lens having this same irregularity of curvature in its different meridians, you will have a satisfactory working basis for understanding the meaning of the ocular defect known as astigmatism; for it must be apparent, first, that those rays of light which pass through the more convex meridian will be bent more rapidly than those passing through the less convex meridian; and second, that since they are bent at different angles the rays cannot all meet at a single point on the macula. Persons afflicted with this aggravating defect very much overtax their ciliary muscles in usually unsuccessful attempts to refract all rays equally, and they are rarely able to see sharply and clearly, the reason being, of course, that while some of the luminous rays focus at the macula, many of them strike the retina at

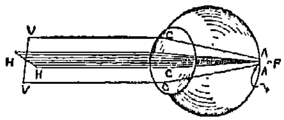


FIG. 70. THE ASTIGMATIC EYE

Parallel rays of light, *HH*, on a horizontal plane are focused on the retina; parallel rays of light, *VV*, on a vertical plane focus behind the retina at *F*, making the image on the retina at *AA* blurred and indistinct. (*By courtesy of the Eye Sight Conservation Council of America.*)

various points around it. The unevenness of curvature of the astigmatic eye may be either localized in the cornea or the lens, but is more usually characteristic of the former. Figure 71 shows the 'astigmatic chart,' by which the particular axis or axes at fault may be detected by the examiner.

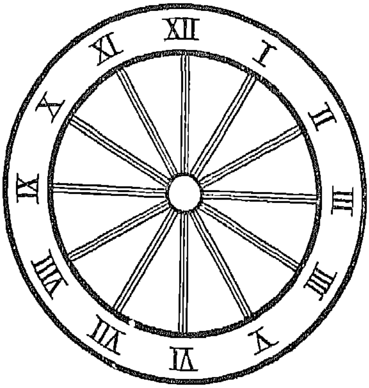


Fig. 71. The Astigmatic Dial

Correction of the astigmatic eye is accomplished by means of a cylindrical lens (Figure 72) which permits those rays entering one meridian to be refracted, while not affecting those entering the other. By setting the lens over the eye in the plane corresponding to the curvature of the astigmatism, the refractive error is corrected effectively.

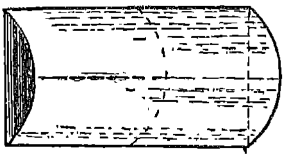


Fig. 72. A Cylindrical Lens

Strabismus. As we have seen in a previous paragraph, the recti muscles in a normal pair of eyes are so nicely adjusted that the two eyes move always on axes that are parallel to one another. The necessity for this axial parallelism arises from the fact that in order to insure a clear bifocal image of the object fixated, both eyes must converge upon it. Any deviation from this condition of balanced parallelism of the two axes produces what is popularly known as 'cross-eye' or 'squint.' Oculists commonly call the defect *strabismus*.

Most typically in strabismus the eye concerned turns either inward, nasally, or outward, temporally; although it may be directed upward, downward, or obliquely toward any corner, depending upon the muscle or muscles involved. The condition may be either congenital, or due to a high degree of myopia or hyperopia, or to disease, or to injury. The second of these causes, defective vision, is perhaps the most common cause of strabismus. The physiological explanation of the very frequent correlation between anomalies of vision and errors of convergence is an interesting one. The brain centers which control the accommodative process are correlated sympathetically with those controlling the recti muscles, so that whenever the former are innervated by a strong impulse the latter are likewise strongly innervated. In the normal eye this nice balance between the action of the accommodation and of the convergence muscles is maintained beautifully. When, for example, a distant object is fixated the ciliary muscles are not required to exert their pull upon the lens, and neither need the recti muscles converge the globes. Conversely, when a near object is fixated the lens must be thickened and the eyes must be converged; and as the object is brought nearer to the eyes the former must be still more bulged and the latter still more converged. Under all normal conditions the proper complementary balance between the action of the ciliary and of the recti muscles is maintained to perfection.

In the hyperopic eye, as we saw, accommodation for either near or distant objects is maintained only by definite exertion on the part of the ciliary muscles, this exertion becoming the greater according as the object fixated is brought nearer to the eye. Since now, by the very nature of the correlation existing between the two controlling brain centers, innervation of the ciliary muscles is associated with innervation of the recti muscles, it is obvious that when the

hyperopic eye accommodates, the recti muscles are innervated out of proportion to the need and consequently a continuous strain is placed upon them, which becomes greater for near work, like reading, sewing, etc. In order to avoid this extremely fatiguing strain the subject commonly forms the habit of fixating the object with one eye — the better — thus permitting the other to contribute a secondary retinal image, which is disregarded. Falling thus into disuse, the non-conforming eye very swiftly begins to deteriorate, if indeed it has not already done so, and may ultimately become practically sightless. Strabismus of this type (i.e., convergent 'squint' of the far-sighted eye) usually develops very early in life, often in the pre-kindergarten period. If properly fitted with convex spherical lenses immediately upon the appearance of strabismus, the eyes may be corrected of their hyperopia and the difficulty can usually be overcome. When, however, there is any considerable delay, the vision in the deviating eye may be impaired and even the stimulus provided by glasses will be insufficient to pull it into an axis parallel to the other eye.

In the myopic eye, since very little accommodative effort is placed on the ciliary muscles, there is but weak correlative innervation of the recti muscles; consequently 'divergent strabismus' develops; i.e., a condition in which one or both eyes turn outward, producing the so-called 'wall-eye.' This defect is less likely to appear in early childhood, being commonly associated with adult life. Correction is made by concave spherical lenses, if put on shortly after the appearance of the condition. Oculists are also able in many cases both of convergent and divergent strabismus to give a type of calisthenic training to weak or non-coöperating recti muscles and so bring them in to the spontaneous exercise of their proper function. In some cases — notably in congenital cross-eye — recourse to operative treatment is often

had; recti muscles that are too short or too long may thus be lengthened or shortened as the case may require.

The importance of eye-strain in childhood. While the standards and technique of testing the vision of school children vary considerably in different communities, yielding somewhat contradictory results, it seems reasonable to conclude from the great number of statistics available that not far from twenty per cent of the children in the schools of the United States have some form of ocular defect sufficiently pronounced to require glasses to correct or relieve them. This would mean that in a schoolroom of forty children, at least eight are in need of expert attention. In addition to these cases of obvious need, there are probably as many more who have milder errors of refraction which cause them more or less discomfort. Let us now inquire what are the effects of this constant eye-strain upon the child, understanding that by 'eye-strain' we mean the fatiguing effects of constant over-effort on the part of either ciliary or oculomotor muscles — more commonly of the former — to produce clear, sharp vision.

The child who is suffering from eye-strain can more often than not be identified by the teacher, since he presents one or several local symptoms, which Dr. Terman enumerates as follows: [1]

1. Painful eyes.
2. Spasm of the eyelids.
3. Itching, smarting, or watering of the eyes.
4. Congestion of the eyes.
5. Sensitiveness to light.
6. Frowning.
7. Blurred vision.

Every child who manifests one or another of these symptoms should be regarded by the teacher as a possible sufferer

[1] Terman, L. M.: *The Hygiene of the School Child*, p. 267.

from eye-strain, and should be by her referred to the school nurse or physician for a careful ocular examination at the eye clinic. Not only may serious future impairment of vision be thus prevented, but a long list of other more general systemic complications frequently resultant upon chronic refractive errors of vision.

Students and laymen generally do not ordinarily appreciate the close causal relationship between trouble with the eyes and trouble with the head and with other parts of the body until they make the discovery that of the twelve pairs of cranial nerves, no less than six have some connection with the eyes; and also that several of these are intimately connected with nerve routes to or from other more remote organs of the body, notably the stomach and the digestive system. In consequence of these connections made by the cerebro-spinal and the autonomic nervous system between the eyes and other organs, any over-activity of the former, as in the case of eye-strain, is likely to be reflected in reflex symptoms anywhere along the line of nervous intercommunication. Thus, so marvelously is the entire nervous system integrated that whenever one part of it is unwontedly stimulated, other parts, adjacent or remote, are affected.

From this circumstance it comes about naturally enough that one of the most frequent concomitants of eye-strain is some form of headache, notably though not necessarily localized in the upper frontal part of the cranium or in the general occipital region. Persons in whom refractive errors are not so high but that their eyes are able to accommodate with more or less effort are very commonly the victims of either dull or acute pains in the head, which may become so chronic as to make life wretched indeed. Especially, of course, is this true of persons who use their eyes to any extent in reading or other near work. It is the experience of most oculists that three quarters of their patients were first

led to seek their help because of headache. In the schoolroom, while there is no very satisfactory way of finding out exactly the correlation between refractive errors and headache, there is no doubt but that it is high. In addition to actual head pains, persons with defective visual apparatus often suffer from dizziness, faintness, and vertigo, which very often can be traced to reflex nervous disturbance due to errors of refraction or of convergence, and which quite commonly are found to disappear after a competent ophthalmologist has corrected the visual difficulty.

Eye-strain in school children. All this is of particular significance for the teacher of children, for it is apparent that eye-strain has an unfortunate effect not only upon the physical organism, but also upon the spirits of the child as well. Adults like Charles Darwin can, under the stimulus of their own genius or purpose in life, pursue indefatigably their chosen work in spite of protesting eyes and paralyzing headaches. But school children are made of tenderer stuff than their adult progenitors, and come very quickly to reflect in the quality and spontaneity of their performance the baneful effects of imperfection or deficiency in the psychophysical organism. And of all the types of deficiency met with in this organism, few are prone to affect more the work or the spirits of children than are those arising from eye-strain.

It is unfortunately true that the presence of eye-strain in children is not easily demonstrable in a great many cases, since often considerable errors of refraction are not apparent in vision which is not below the normal. On the other hand, there are undoubtedly many errors too slight to be a probable source of trouble, either at the present time or subsequently. This fact makes it very difficult indeed for us to know, with any high degree of exactness, how many eyes there are needing correction in the schoolrooms of a given

community. Absence of uniformity in making eye tests, in agreement as to what constitutes a defect, and in recording the percentages of defects found, has resulted in quite divergent statements as to the prevalence among school children of visual deficiencies. Thus, the Eye Sight Conservation Council states that from tests of 483,154 children, in 19 cities, the reported percentages of eye defects, corrected and uncorrected, varied all the way from 3.5 to 58.0 per cent, with an average of 21.9 per cent. What is urgently needed is a uniform system of ascertaining these deficiencies which shall be employed carefully by all who make tests of children's eyes in the schoolroom.

The general condition of health of the child's organism is a factor of some importance in this connection, for it is the testimony of many expert workers in the field that a small error of refraction in the eyes of a healthy, robust child may be taken care of by the ciliary muscles without producing any apparent ill-effects physiologically upon the general system; while on the other hand an amount of error no greater — or even less — in the eyes of a weak, or nervous, or anæmic child will usually be correlated with reflex headache and a heightened nervousness. In general it may be stated, in the words of the Conservation Council, that "those who have defects of low degree are the ones who invariably suffer from headaches and the various nervous disturbances resulting from eye-strain, because the eye muscles can exert enough effort to overcome the small errors, whereas large errors cannot be overcome, and frequently do not cause discomfort, but merely poor vision." Since this is true, the problem of determining accurately which children are actually suffering from eye-strain becomes a still more difficult one to solve.

Testing the vision of school children. As we stated above, there is a lamentable lack of uniformity in the tech-

nique of administering and evaluating schoolroom tests of vision. Thus far (1925) some twenty States have enacted statutes requiring that visual acuity tests be made periodically, in order that the most glaring cases of ocular defects may be discovered and corrective treatment actively and urgently recommended to parents. So inadequate are the provision and the enforcement of these laws, however, that to-day less than a third of the children in the schools of the United States are receiving visual tests.

In most cases the tests are given by the teacher or by the school nurse, who is supplied by the educational authorities with the test cards and record sheets, together with simple instructions for administering the tests and evaluating the results. It is true, of course, that teachers and nurses are not trained ophthalmologists, and hence can venture only rough diagnoses of ocular conditions in their children. It is equally true, however, that only an infinitesimal percentage of children whose eyes are examined by and in the schools would ever have them examined by the expert during the school years. Consequently, rough and inadequate as the teachers' tests are, whatever positive results they obtain are all pure gain for the children found deficient. The teacher should therefore enter whole-heartedly into this phase of her work, and equip herself as carefully as possible to handle the tests intelligently. The object of the annual or semi-annual testing of the pupils' eyes is to discover those children who appear to be deficient in visual acuity, and report their finds where they are of significance to the parents who, theoretically at least, will procure professional examination by the expert.

1. *The apparatus.* The older, and still very widely used, test card for literates is some form of the Snellen Letter Test Card. (See Figure 73.) This consists of a graded series of lines of pied type, so arranged that the height and size of the

letters in each line are less than in the line next above, and greater than the one next below. There are several forms of this test, constructed on the principle illustrated in the

30 A L D O T F

20 F L O T D E X C

10 V E D T O F C A L

FIG. 73. THE SNELLEN LETTER TEST CARD

This is only a portion of the card; the size of the letters has been reduced one half. The lowest line should be seen at a distance of 10 feet; the second line at a distance of 20 feet, etc.

figure. The chief objection to all of them, and to other types of letter test card, is that, unless they are handled with extreme carefulness by the teacher, they may be committed to memory by the pupils and so their purpose be destroyed.

The Snellen Test Symbol Cards are now having wide use in the schools of this country. (See Figure 74.) The symbols are arranged in a graded series of lines precisely the same as the letters in the letter card, but the distinct superiority of the former over the latter lies in the fact that identical E-symbols instead of letters are used, thus precluding the possibility of children learning them by rote.

20 FEET

FIG. 74. LAST LINE OF THE SNELLEN TEST SYMBOL CARD

2. *The technique.* Regardless of whether a letter or symbol card be used, the technique of administering the tests is substantially identical. The testing should be done as early in the school year as practicable, preferably in September. A room should be selected that is well-lighted, and each child tested under the same conditions. The card is to be hung on a level with the head, and in a clear light, care being taken that the glare of the sun does not fall upon it nor upon the children's eyes. The child being tested should stand at a distance of twenty feet, and directly in front of the chart. The teacher holds a small card over one eye, being careful not to press it down against it, thus distorting somewhat the image seen by the other eye. The child is instructed to read aloud from left to right the smallest line of E-symbols he can see upon the card, stating in each case whether the prongs point right, left, up, or down. Primary children who are unable to tell the directions are given a large E (Figure 75), and directed to turn its prongs so that they will point in the same direction as the prongs of each symbol on the chart.

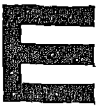


FIG. 75
THE SNELLEN 'E' CARD

For such young children, and for illiterates generally, the McCallie Test Cards may be used to advantage. On these are pictured a bear, a boy, and a girl, each holding a tennis racquet. On some of the cards, the black dot, standing for the tennis ball, is in the center of the child's

racquet; in some, it is in the bear's racquet. On others it is missing altogether. As the examiner holds up card after card, at the regulation distance of twenty feet, the child must tell who has the ball.

3. *Recording the results.* On the Snellen Symbol Test Card (Figure 74), there is a number beside each line which shows the distance in feet at which the line should be read by the normal eye. Thus, the upper line is marked 50, the second 40, the third 30, and the lowest one 20. The normal eye can read the top line at a distance of 50 feet; the second line, at a distance of 40 feet, etc. A mistake of two symbols on the two lower lines, and of one on the two upper lines, is allowable.

If, standing 20 feet from the card, a child is able to read correctly with his right eye four or more of the symbols on the 20-foot line, the teacher records his vision in that eye as $\frac{20}{20}$, the numerator standing always in visual tests for the distance at which the subject stands, and the denominator standing always for the smallest line that can be read satisfactorily. If the child is able to read with his left eye only three or less of the symbols in the line, the acuity of that eye is to be recorded as $\frac{20}{30}$; i.e., at a distance of 20 feet the eye can distinguish only what it ought to be able to read at 30 feet. The eye is, consequently, two thirds of normal in its visual acuity. Similarly, if the symbols on the 40-foot line are the smallest that can be read, the record will be $\frac{20}{40}$; if those on the 50-foot, it will be $\frac{20}{50}$. In case a child cannot see the fifty-foot line, he should be directed to approach the card slowly until he reaches a point where he can just distinguish it. If five feet is the greatest distance at which

the 50-foot symbols can be perceived, the record will be noted as $\frac{5}{50}$ ($\frac{1}{10}$ of normal). Notification of parents is required by law in many States if the acuity is found to be low. In Massachusetts, such notification is mandatory only when the vision in either eye is found to be $\frac{20}{40}$ or less. It is unfortunate that a child's vision must be reduced to fifty per cent of normal before parents can be appraised of the fact.

As we pointed out above, the visual acuity tests available for use by teachers and school nurses are but rough approximations of scientific procedures.[1] Oftentimes teachers, careless or unskilled in the use of the test cards, get results that prove to be quite inaccurate when checked up subsequently by the expert. This fact should not, however, lead teachers to assume that the time spent in systematic eye-testing of their pupils is in large measure wasted: rather it should inspire them to so systematize and mechanize their procedure that, except within the limits set by the nature of the tests themselves, errors cannot occur. The annual examination of the eyes should be deemed by all concerned to be the most important examination conducted by the teacher during the entire year.

Some important additional aspects of the hygiene of vision. A dozen or more years ago it was commonly contended that the schools were primarily responsible for the development of visual defects, especially of myopia, in children and adolescents. It was claimed that the excessive amount of book-work and fine seat-work demanded of chil-

[1] Teachers who have the time and equipment will be in a position to make visual acuity tests that are somewhat more accurate by following the procedure explained in connection with Test 14, in Professor G. M. Whipple's *Manual of Mental and Physical Tests*, vol. 1, *q.v.*

dren tended to weaken and strain their eyes, and hasten the day when vision would be much impaired and recourse must be had to glasses. It is undeniably true — a fact amply established by statistical studies — that myopia does increase enormously in the junior and senior high-school grades. The fact, however, that the eyes of persons who have never attended schools — even primitive tribesmen — are known to undergo similar modification frequently in the adolescent period, raises the question as to whether the school is the only or even the chief factor in the development of myopia. Certainly heredity, both racial and family, is responsible for much of it; so also are the marked changes in the shape of the head and face that occur during early adolescence, when the bony framework assumes its characteristic hereditary form.

Undoubtedly, though hardly the principal causal factor, the school is an important contributing factor to the development of eye defects, especially myopia. It is therefore of some importance that teachers be familiarized with certain fundamental principles of ocular hygiene which can and should be observed carefully in our schools. We shall consider these briefly, under several captions, as follows.

Not too early or long continued work. The older type of school was more reprehensible than the newer in one very vital respect: it required altogether too much near work, which necessitated too much accommodative effort on the part of the ciliary muscles. Not only did it require long periods of close application, but it made scant effort to provide equipment and apparatus calculated to engender the minimum amount of ocular fatigue and strain. The print in the textbooks was small, and few pictures were introduced to attract the eyes occasionally from the printed line. Too much emphasis was placed upon handwriting, especially in the lower primary grades, and not enough use

was made of the blackboard. The same general criticism applies to much of the work of the early kindergartens, which required an excessive and wholly unpedagogical amount of close application to small and circumscribed operations.

The newer school has attempted, rather successfully in the lower grades, to eliminate a considerable amount of work of this sort. The best primers and early readers are now printed in clear, large type, properly gauged to the age of the children making use of them. They contain numerous large pictures, are printed for the most part on dull paper which prevents glare, and are so arranged that the printed lines are short and the margins wide.

The following set of standards of the New York City Board of Education, with reference to schoolbooks, is representative of the best current opinion and practice on this subject:

1. That no calendered or coated paper be permitted in the textbooks given to the children, as the dazzle of such paper is injurious to their eyes.
2. That half-tone pictures be not permitted in the schoolbooks, but that simple, easily seen outline pictures be substituted for them.
3. That the length of line in schoolbooks be from a minimum of $2\frac{1}{2}$ inches to a maximum of 3 inches.
4. That the space between lines be not less than 3 mm. ($\frac{1}{8}$ inch).
5. That in reading, the children hold their books at an angle of 45 degrees, and that in oral reading they be required to look up frequently.
6. That after a lesson requiring close work the children be asked to look at the ceiling or out of the window to change the focus of the eye and rest the muscles of accommodation.
7. That classrooms be equipped with loose chairs of different sizes so that children may sit in seats that fit them, placed where they can see best.
8. That in the first two grades of school all writing be upon blackboards instead of on paper.

The following represents the standards adopted by the British Association for the Advancement of Science as desirable typographical features for all school textbooks.

Table 9. Standard Typographical Table for Schoolbooks
Prepared by the British Association for the Advancement of Science

Age	Minimum Height of Face of Letters (mm.)	Minimum Length of Alphabet of Small Letters (mm.)	Minimum Inter-linear Space (mm.)	Maximum Number of Lines per Vertical 100 mm., or 4 inches	Maximum Length of Measure of Line (mm.)
Under 7 years.....	3.5	96	6.5	10	
7 to 8 years.......	2.5	72	4.0	15	100 (4 in.)
8 to 9 years.......	2.0	53	2.9	20	93 ($3\frac{2}{3}$ in.)
9 to 12 years......	1.8	50	2.4	22	93 ($3\frac{2}{3}$ in.)
Over 12 years.....	1.58	47	2.2	24	93 ($3\frac{2}{3}$ in.)

On page 316 are presented some sample lines which illustrate the above dimensional rules.

Avoidance of glare reflected into the eyes. One of the most trying of all the situations that confront the human eye is presented when the glaring rays of unfocused light are reflected into it from bright or shiny surfaces, or when they are thrown into it by a source of light of excessive volume placed too near the field of vision. The former may be illustrated outside the schoolroom by the fatigue and extreme unpleasantness of the glare reflected into the eyes from a carpet of snow, especially if one walks or rides along it for some time; the latter condition may be illustrated by the annoyance experienced when one attempts to read at a table on which is a strong but unshaded lamp placed close by the book. In both cases, glare shines in the eyes, and this glare becomes the more annoying as the intensity of the light is increased. Instead of having clear images of the book or other work upon the retina the individual who is

UNDER SEVEN

This type may be used for books to be read by

AGE SEVEN TO EIGHT

This type may be used for books to be read by children from

AGE EIGHT TO NINE

This type is suitable in size for books to be read by children from eight to

AGE NINE TO TWELVE

This type is suitable in size for books intended for readers over nine years old. The size of the

OVER TWELVE

This type is suitable in size for books intended for practiced readers over twelve years old. The size of

STANDARD TYPES TO ILLUSTRATE TABLE 9

exposed to glare, whether direct or indirect, has other bothersome images of brightness which make hazy and in some cases even obliterate the focused images. The strain thus put upon the eyes in their attempt to disregard the glare and attend only to the images registered, is very fatiguing, not to say intolerable.

Many workers at desks and in shops suffer continually from glare reflected into their eyes indirectly from their work by rays of light thrown upon it, as may be appreciated by studying Figure 76.

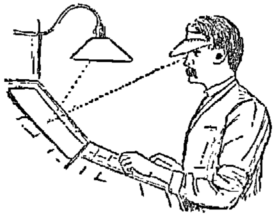


FIG. 76

Showing harmful effects from reflected glare. (*Courtesy of the Eye Sight Conservation Council of America.*)

In the schoolroom there are several sources of glare. In a later chapter (see Chapter XIII) we shall devote considerable attention to the problem of schoolroom lighting, and shall there discuss the avoidance of direct glare from improperly placed light units. The chief sources of reflected glare in the schoolroom are obviously the shiny surfaces of walls, desk-tops, furniture, glossy book leaves, poorly placed blackboards, and the like. And yet how common is the spectacle of enterprising school boards and principals employing interior decorators in the summer vacation to give the desks their annual coat of shiny varnish! Only dull, matt finish should be permitted upon any article of furniture in the schoolroom. Walls and woodwork should be tinted a flat olive, or buff, or some other pleasing shade, with no varnish over it. If you will look over the books used in any grade in our public schools you will find that most publishers, in response to the appeal of schoolmen, are now making available for the schools texts in every subject printed on dull paper from which there is no glaring reflection of light rays into the eyes.

Unfortunately blackboards are still all too often found placed beside or between windows in such a way that the eyes of pupils must look directly toward glaring light whenever it is necessary to read from the board. The result is, of course, that the eyes are often dazzled and, despite their best efforts, the pupils are unable to decipher anything written upon the board except with the greatest ocular strain. The proper place for the most used blackboards is on the side of the room opposite the windows, where they can be clearly and easily seen under all conditions.

Adjustable and adjusted seats and desks. Children, especially in the lower grades, are not noted for the hygienic perfection of their sitting posture. Their abdominal, back, and shoulder muscles are not overstrong, and they fatigue much more quickly than do those of adults. Since this is true, it is quite natural for pupils to degenerate, within a surprisingly few moments after being cautioned by the teacher to 'sit up in their seats,' into very faulty postures. This means usually that they will bend forward over their books and in so doing bring their eyes nearer the printed page. The lenses must of course accommodate through the action of the ciliary muscles, and consequently eye-strain and fatigue result rather quickly. As a refreshing alternative to this, the child may shortly slide forward in his chair until he is sitting on the tip of his spine, stand his book up on the desk-top, or hold it poised in mid-air before him, and compel his oculo-motor muscles to hold his eyes in an unwonted position the while he reads or studies. The effect of this position is no less conducive to eye-strain than was slumping forward over the book.

While it is true that restlessness and fatigue will overtake school children sooner or later even under the most comfortable conditions of seating, it is a fact that well-adjusted chairs and desks will go far toward delaying the onset of

fatigue, and so lessen the probability of excessive eye-strain from faulty reading posture. With his chair and desk accurately adjusted, it is infinitely more easy for a child to maintain good posture; indeed it is likely to be more comfortable to sit erect than it is to slouch forward over the desk or down upon the spine. In Chapter XIII we shall discuss more in detail the mechanical phase of the adjustment of school furniture in the interest both of comfort and of good posture and freedom from eye-strain.

Observance of hygienic reading conditions. Without question the present is the greatest reading age since the invention of the printing art. The multiplication of books is exceeded only by that of newspapers and magazines of every conceivable type and variety. More people — juveniles and adults — are using public libraries than ever before. Into every home there enters daily at least one and often several newspapers. The circulation of several of the best known weeklies and monthlies in the homes of America is now in the millions, not to mention the enormous bulk of reading material supplied through the cheaper sort of magazines and papers. In view of the stupendous amount of reading done, it becomes a matter of the highest moment that eye conservation be preached and practiced in every home and school in the land. Teachers should stress as much the teaching of hygienic reading conditions as they do that of hygienic postural, or dental, or other personal habits.

Increasingly in our schools the custom of assigning home-work, particularly in the lower and intermediate grades, is being abandoned, largely because of the extreme likelihood of the lighting and other conditions in the great majority of homes being wholly unsuited to the safe use of the eyes in reading and study. It is unfortunately true that the lighting in most homes is anything but good. Especially is this

the case in tenement houses, whose proprietors are likely to be averse to spending more money upon them than is necessary for their bare upkeep. Lighting fixtures are about the last thing to be improved in houses of this type. Even in the better homes, one commonly finds very faulty illumination, the most common evil being unquestionably the bare lamp or flame. Reading by an artificial-light source which is either radiated directly or reflected indirectly into the eyes is extremely damaging to the ocular mechanism. Light from such damaging sources should not be permitted in our homes. Semi-indirect lighting, which consists of a diffusing glass bowl inverted to throw much of the light upward to the ceiling and thence downward into the room, if well diffused, bathes the whole room in a soft light, eliminates glare as well as deep shadows, and is strongly to be recommended for living-rooms and libraries. Were all homes to which children return at night properly illuminated after this fashion, home-work in small amounts might very properly be assigned.

In addition to faulty lighting, there are other factors, however, which render the assignment of home-work inadvisable in the lower grades. Among these may be mentioned the proverbial carelessness of children in reading by twilight, refraining to turn on the lights as long as they can see to read by drawing a chair nearer to the window; and their proneness to read in faulty postures, as, for example, huddled or cramped into an easy-chair, reclining on a sofa, and even when lying in bed before going to sleep. These and other considerations operate to convince teachers of the general undesirability of requiring home-work of any amount or regularity of their children. In this connection, children should be taught to avoid rubbing their eyes, looking at very bright objects, reading by a poor light, and in any other way misusing their eyes. Opportunity should be

provided very frequently during the school day for the pupils to look away from their books and rest their eyes for a few moments.

Sight-saving classes for children having low vision. It is a decidedly unpleasant fact that the eye-testing program reveals a considerable number of children whose visual acuity is very low — too low indeed to make it possible for them to keep up, even at the expense of ruining what vision they have, with their normally seeing mates. In many of our leading communities, those pupils who do not have more than five to ten per cent or so of normal vision are enrolled in special 'sight-saving' or 'conservation-of-vision' classes. Classes of this type were first started in Cleveland, in 1913, since which time similar ones have been organized in many other cities, including Albany, Boston, Buffalo, Cincinnati, Detroit, Grand Rapids, New York, Philadelphia, and Rochester. In Cleveland there is a 'conservation-of-vision' pupil for about every 1000 of the school population. In other cities, this ratio has been found to run as high as 1 to 500.

In the sight-saving classes every effort is made to place the minimum of strain upon the already very weak eyes of the pupils. To this end, special textbooks, printed in large, bold type, outline maps printed on slated cloth to make it possible to use chalk in inserting details; and soft pencils, with paper ruled with wide spacings, are provided. Desks are movable so that they may be drawn near the blackboards, maps, etc., or near the best sources of light. In addition to the usual curricular subjects, special emphasis is placed on manual work, in the hope that children who are doomed to go through life severely handicapped may be able to use their hands skillfully and satisfyingly. Drawing, domestic science, music, and hygiene, in addition to basketry, canning, weaving, etc., are taught. It is scarcely

necessary to recommend here that every sizable community — certainly those having a population in excess of 25,000 — should provide for the organization of one or more of these conservation-of-vision classes. Failure so to conserve the dim and failing eyesight of those children low in the visual scale means future privation and distress on the part of the individuals, and expense and annoyance on the part of society in general.

TEACHING POINTS IN THIS LESSON

A. Structure and Function

1. The action of the iris and its relationship to the pupil.
2. The eye as a camera: shutter, lens, plate, etc.
3. The action of the lens in near vision.
4. Parallel action of the two eyes.
5. Binocular vision: the stereoscope.

B. Hygiene

1. The eyes of primitives, animals, and civilized peoples.
2. Demands made upon the eye by modern life.
3. The near-sighted and the far-sighted eye: correction by glasses.
4. Astigmatism and its correction.
5. Cross-eye.
6. The demands made by the school upon one's eyes.
7. Eye-strain: causes, symptoms, treatment.
8. Importance of the school test of the eyes.
9. Wise alternation of near work and rest periods.
10. Hygienically well-constructed books to study and to read.
11. Importance of avoiding glare — notably in the schoolroom.
12. Bad sitting posture in school and its effect upon the eyes.
13. How, when, and where to read and study.
14. Well lighted and poorly lighted homes, shops, and schools.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Look up, in some standard text in college physics, the discussion presented on the general subject of light refraction. Epitomize this material, and be prepared to present it briefly in class.
2. Perform one of the experiments suggested on pages 285 and 286; write up your results and conclusions in the notebook.

3. Construct a figure showing the emmetropic, myopic. and hyperopic eye in a single drawing, together with diagrams of the lenses necessary to correct the two last mentioned conditions.
4. Secure from the instructor a Snellen or other test card, and test for visual acuity the eyes of several children in the practice school. Make a record of the results and hand them in.
5. Look through a recent yearbook of the *Proceedings of the American School Hygiene Association*, and form a general statement from the material therein presented concerning the prevalence of eye defects among the school population.
6. Make a survey of the textbooks used in the first six grades of the practice school, for the purpose of determining in how far the size and leading of type conform to the standards for schoolbooks laid down in the lesson. Compare with these the print used in early schoolbooks, like the *Orbis Pictus*, the *New England Primer*, etc., and even in texts in common use a generation ago.
7. Make a survey of the illumination of your own home, especially the living-room or library. What type of fixtures is used? Is the light well diffused for reading? Is there any glare, direct or indirect?
8. Appoint some member of the class to write to the Eye Sight Conservation Council, New York City, Times Building, for any current informational data they may possess bearing on the general topic of vision and its conservation. When this material arrives, let a committee be appointed to digest and epitomize it for the class, and afterwards see that it is filed or posted for future reference.

SELECTED REFERENCES

1. Posey, W. C. *The Hygiene of the Eye.* (General Reference.)
2. Pyle, W. L. *A Manual of Personal Hygiene*, section 5.
3. Terman, L. M. *The Hygiene of the School Child*, chap. 14.

CHAPTER XI

THE MAJOR SENSES

II. AUDITION

1. *Structure and function*

The external ear. Next in importance to the sense of sight is that of hearing. Particularly is this the case from the point of view of the educative process, which is almost equally dependent upon efficient functioning of both these major gateways to consciousness.

Those portions of the ear that are actually visible and tangible comprise but a small part of the total auditory end organ, just as the visible parts of the eye represent only a small part of the optical end organ. The function of the ear is, of course, to collect the sound waves vibrating about the body, pass them inward to the inner ear, and there metamorphose and transfer them as nerve impulses to the auditory centers of the brain. Anatomists easily subdivide the ear into three distinct parts: the *external*, the *middle*, and the *inner*. We shall study each of these parts briefly.

Structurally, the external ear presents two features: the *pinna* and the *meatus*. The former of these, the pinna, is that part of the outer ear which is visible, and which projects from the side of the head. Its general form is concave, but it has several irregular depressions and elevations, and terminates at the bottom in a flabby lobule. The pinna, except for the lobule — consists principally of cartilaginous tissue, covered with a taut, closely adhering dermis, and the whole is attached to a prominent margin of the temporal bone. In thickness, the pinna varies between two and four milli-

meters, and is consequently decidedly thin and elastic. It is attached to the side of the head by two broad, strong ligaments.

The specific function of the pinna is to collect sound waves and direct them inward against the ear-drum. Why are elderly people, and others who are hard of hearing, often seen to place a hand behind the ear when listening to a speaker? In animals the muscular equipment of the outer ear is kept so efficient through practice that they are able to point them forward or backward in the direction of the source of the sound. Witness the horse, frequently turning one ear backward to hear the urgings of the driver, while the other is turned forward or sidewise to catch any sounds coming from those directions. The muscular equipment of our human ears is, however, poorly developed, and while with training it is found possible to move the ears slightly, they have lost most of their primitive mobility through long ages of adaptation to an environment in which a high degree of sensory alertness is less essential to preservation. In this evolutionary process of shrinkage, the smoothness and regularity commonly observable in the pinna of the animal have been lost, and the external human ear has become quite strikingly irregular.

The second important feature of the external ear — the *meatus* — is the narrow canal running from the pinna inward as far as the ear-drum. The meatus is some twenty-five millimeters in length, inclining at first as it leaves the pinna somewhat upward and forward, then becoming horizontal and turning sharply backward, and finally turning forward again and downward to the drum membrane. Its diameter is slightly less internally than at the external point of origin. Its walls are cartilaginous for about half the distance, and osseous the rest of the way up to the tympanum. The *ceruminous glands*, which secrete ear-wax, as well as typical

sebaceous glands, are very numerous in the dermal lining of the canal, and their ducts open upon its surface. The function of the meatus is to act as a conduction tube through which the sound waves are passed to and thrown upon the ear-drum.

The tympanic membrane, or ear-drum. Stretched tightly across and closing the inner end of the meatus is the *tympanic membrane,* commonly called the 'ear-drum.' Structurally this membrane, which forms the bounding wall between the external ear and the middle ear, is a fibrous disc, ellipsoidal in shape, having a thickness not in excess of 0.1 mm., and a diameter of some 9 or 10 mm. It is covered externally by the dermis of the meatus, and internally by the mucous membrane which lines the middle ear. As its name indicates, the tympanic membrane responds to the beat of sound waves upon it much as the head of a drum does to drumsticks, by vibrating or quivering very minutely but rapidly. These minute vibrations are contributed to the tiny bones in the middle ear, and by these are passed inward into the inner ear.

The middle ear. Just on the inner side of the tympanic membrane, within the substance of the temporal bone, is a narrow cavity some 3 or 4 mm. in lateral width by 15 mm. in anterior-posterior width, and the same in depth. This cavity is the middle ear, or 'tympanum.' Within it are three tiny bones, which coöperate very interestingly in conducting the sound waves from the outer ear across the middle to the inner ear. These three bones, illustrated in Figure 77 are, in order, the 'hammer,' or *malleus;* the 'anvil,' or *incus;* and the 'stirrup,' or *stapes* — so-called in each instance because of striking resemblances which they bear to these three objects. The handle of the malleus descends along the inner surface of the ear-drum to a point a trifle below the center. The handle is firmly attached to the

drum along its entire length by means of a cartilaginous layer. The head of the malleus fits neatly into the body of the incus, with which it forms a smooth articulating surface.

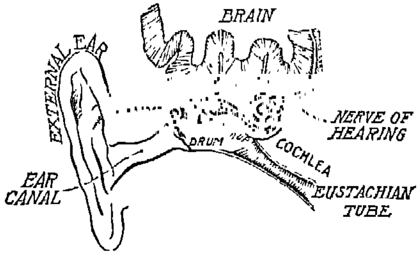


FIG. 77. PARTS OF THE HUMAN EAR

The three bones in the middle ear are named, from their shapes, the hammer, anvil, and stirrup. The cochlea, shaped like a shell, is in the internal ear.

On the opposite side of the incus there are two horns, one of which serves as a point of attachment for the ligaments by which it is held movably in place against the tympanic wall. The other, and somewhat longer horn, passing inward and downward in a plane parallel to the malleus, articulates smoothly with the head of the stapes, the latter being cupped and lined with cartilage to receive it. The base of the stapes, a thin osseous plate covered with cartilage, fits lightly into the 'oval window' — the *fenestra ovalis* — which opens into the inner ear, and which is also rimmed with cartilage. These two articulating cartilaginous surfaces are woven together by a network of elastic fibers which permit the stapes to move smoothly in and out as the vibration of the sound waves upon the drum is contributed by the malleus and incus to it.

What happens, then, in the middle ear during the passage of sound waves through it to the opening into the inner ear is somewhat as follows. The beating of the waves upon the ear-drum, upon which the pinna and the meatus have coöperated to collect and converge them, causes that membrane to vibrate slightly, almost imperceptibly. This narrowly constricted movement is contributed obviously to the malleus, the handle of which is affixed firmly to the drum, all

of whose movements it must in consequence follow. The inward impulsion of the drum thus causes the malleus to move inward; the head of the malleus being articulatory with the body of the incus, the latter bone is simultaneously moved inward; the longer horn of the incus being similarly articulated to the head of the stapes, that bone too moves inward simultaneously, pressing lightly its base, piston-like, into the oval doorway into the inner ear.

It must not be supposed that the bony walls of the tympanic orifice are smooth and regular. On the contrary, and notably toward the posterior side, they are decidedly uneven and irregular. In this posterior wall, somewhat behind and above the oval window, there is a very irregular depression from which numerous small cavities pass deep into the substance of the temporal bone. To this region of the middle ear is given the name *antrum mastoideum*, and the small cavities are called the 'mastoid cells.' They are lined by a mucous membrane which is continuous with that of the tympanum. The hygienic significance of this region will appear later in our discussion of infections of the middle ear.

One other structure of importance in the middle ear — which, however, has no direct relationship to the auditory sense — is the *Eustachian tube*, which forms a continuous passage between the throat and the middle ear. Indeed, the mucous membrane lining the pharynx, Eustachian tube, and middle ear is a single and continuous tissue. In size, the canal is about one and a half inches long, and from two to four or five millimeters in diameter. Its function is to permit air to pass from the mouth into the middle ear, so that the external atmospheric pressure against the ear-drum may be equalized internally; otherwise the drum would necessarily collapse. Under what conditions do we become conscious of the pressure of air on the two sides of the drum?

The inner ear. It is within the inner ear, or *labyrinth*, that are contained the essential structures of the organ of hearing. The labyrinth lies within the temporal bone, and consists of a complex bony cavity which is divided into three parts: the *vestibule*, the three *semi-circular canals*, and the *cochlea*. All of these are lined with a continuous thin membrane and contain a fluid called the *perilymph*. Coextensive with and floating within the osseous labyrinth is a membranous one considerably smaller. The membranous labyrinth is lined with epithelial cells, supplied at certain points with highly sensitive nerve structures, and filled with a clear fluid: the *endolymph*. The cochlea lies toward the front end of the labyrinth, the semi-circular canals lie toward the rear, and the vestibule lies between and connects the two. As we have already seen, the sound waves, striking upon the ear-drum, cause the stapes to thrust lightly into the oval window. Now the oval window is in the wall of the vestibule, and as the stapes thrusts inward the effect is to disturb somewhat the perilymph in the inner ear. This disturbance is communicated, through the thin wall of the membranous labyrinth, to the endolymph within, where, as we shall see, it stimulates the end fibers of the auditory nerve.

With the semi-circular canals we need have no concern, further than to state that they have to do with the sense of equilibrium. It will be found an interesting study to look up, in some textbook on physiology and anatomy, the structure and function of these canals.

It is exclusively with the cochlea that we are concerned in a discussion of hearing, since it is only within this structure that the auditory nerve is brought in contact with the sound waves transmitted into the labyrinth from without. In appearance (see Figure 78), the cochlea suggests a snail shell, whence its name. It consists of a bony tube which coils spirally $2\frac{3}{4}$ times about a central pillar of bone, both

pillar and tube decreasing rapidly in diameter from the base to the apex of the cochlea. In the winding floor of this membranous cochlea, the basilar membrane, are the structures which contain the cochlear nerve. It comprises an epithelium in which are embedded highly specialized structures known as the *organ of Corti*. The organ of Corti is to the ear what the retina is to the eye. It consists of the very sensitive frayed-out ends of the auditory nerve.

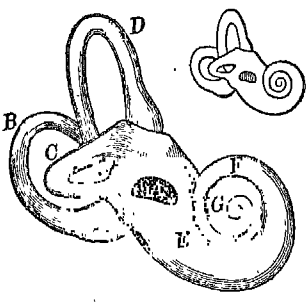


FIG. 78. THE BONY LABYRINTH

Its actual size is shown in the smaller figure. *B*, *C*, *D*, the semi-circular canals; *A*, the oval window, by means of which the vibrations of the stirrup bone are transmitted to the cochlea; *E*, *F*, *G*, the whorls of the cochlea. (From Hough and Sedgwick's *The Human Mechanism*. Courtesy of Ginn and Company.)

The auditory nerve trunk enters the bony cochlea through the middle of its base, passes upward through openings in the central bony pillar, and then radiates outward through the spiral lamina to the basilar membrane, where its branches extend into the endolymph of the membranous canal as tiny, hairlike projections, of which there are many thousands. We are now in a position to trace the entire progress of the sound waves from the time they impinge upon the ear-drum until they actually stimulate the hair-cells of the organ of Corti.

The vibration of the ear-drum, as we saw, moves the malleus, the malleus moves the incus; the incus pushes in the stapes into the oval window. The perilymph in the osseous inner ear is agitated slightly by this pressure, and so agitates the endolymph within the membranous inner ear. This agitation passes through the endolymph of the membranous cochlea up the scala vestibuli and down the scala tympani, setting into sympathetic vibration as it passes over

them the hair-cells of the organ of Corti, i.e., the ends of the auditory nerve. Just why the proper fiber or fibers react to a definite stimulus is not wholly clear, but it appears that each is attuned to its own specific wave length, and will react only to that stimulus. Thus, middle *C* (256 vibrations) always sets in vibration that fiber or those fibers attuned to that specific vibration rate; the *D* next above middle *C* causes its specific fibers to react, etc., etc.

At the lower extremity of the scala tympani, the cochlear tube terminates against the *round window*, or *fenestra rotunda*. This is a circular crevice in the bony wall of the labyrinth across which a membrane is stretched. When the perilymph in the scala vestibuli is agitated by the thrust of the stapes within the oval window, this agitation passes up around the scala vestibuli to the apex of the cochlea, and thence downward again around the scala tympani until it reaches the round window, where its force is spent lightly against the yielding membrane covering it. Were it not for this elastic membrane, the thrust of the stapes could not stir the perilymph — and so the endolymph — along the entire length of the cochlear tube, but would only displace it slightly in the immediate region of the oval window.

2. *The hygiene of the ear*

The social importance of normal hearing. There are estimated to be between 60,000 and 75,000 persons in the United States who are totally deaf. Added to these there are an infinitely greater number of persons who are only partially deaf, but whose hearing is so impaired as to interfere more or less seriously with their happiness and general efficiency. The partially deaf, or 'hard-of-hearing' individual, is tremendously handicapped in all the relationships of life. He misses the inspiration and enjoyment that comes from pulpit, stage, forum, and market-place. His associa-

tions with friends and even with his own family are necessarily limited and restricted, and even though he has taught himself to read lips, he still remains pathetically handicapped. Many trades, occupations, and professions are quite closed to him, and in the pursuit of many more he can achieve but mediocre things. Lacking this universal means of social stimulus, the hard-of-hearing person is driven more and more back upon himself, shuns the companionship of others, and may become morbidly introspective, irritable, and unsympathetic.

Disconcerting and restricting as hardness of hearing is in its effects upon grown-ups, however, it is doubly a handicap to children and young people. For the same reason that we discovered it to be difficult to estimate the amount of visual defectiveness — namely, the lack of uniform standards of examination — it is difficult to make an accurate estimate of the number of children who have an impairment in their hearing sufficient to interfere with normal progress in school. Thus, some years ago one American city reported aural defects in about one half of one per cent of its school population, while another reported aural defects discovered in 23 per cent of the children examined. Of 1000 children examined in London, 50 per cent were reported defective in hearing, while of some 6000 in Stuttgart, approximately $33\frac{1}{3}$ per cent were so reported. It is probably a reasonable estimate, allowing for the discrepancies that arise from the varying standards employed by the investigators and medical examiners, that not far from 5 per cent of the school population have very seriously impaired hearing, and that at least 10 per cent more do not hear normally, and are for that reason definitely handicapped in their school progress.

The hard-of-hearing child does not show up well in school. Charles was eight years old, a repeater in the first grade. He appeared to have very little if any interest in his work,

although he did some things surprisingly well. When called upon by his teacher to participate in the lesson, he looked helplessly at her and said nothing, or if he did venture to respond it was only halfheartedly, and usually what he said was more or less irrelevant to the subject at hand. 'Dull and stupid,' the teacher pronounced him privately to herself, and so indeed he was considered by every one. Charles was but one of many hard-of-hearing children whose deficiencies are missed in the routine medical inspection, and who are certified by the hasty examiner as 'O.K.' in physical condition and development. Careful analysis of Charles's case, however, indicated not only that his hearing was hardly fifty per cent that of a normal individual, but that in all probability his hearing had been seriously and permanently impaired by an attack of scarlet fever which he had suffered when he was five years old! Further examination revealed the fact that Charles was of good average intelligence, with an I.Q. of 106. Here was a case in which a naturally bright child had been misjudged persistently, and quite underestimated during the two or more years that he had been going to school. His 'dullness and stupidity' were conditioned solely by the fact that he was never able to hear sharply and clearly the voice of his teacher, or of those about him, and so could not possibly take intelligent part in the work of the schoolroom. Taking their cue from the teacher, not without plenty of corroborative evidence from their observation of him in the home life, the parents, too, had all but reconciled themselves to the fact that Charles was not overbright. Fortunately, remedial measures were instituted in Charles's behalf promptly upon the real diagnosis of his 'dullness and stupidity,' and within another year, while still below normal in the acuity of his hearing, he had not only completed the first grade satisfactorily and passed well into the second, but was pointed

out with pride by his new teacher as one of the brightest children in her room.

The hard-of-hearing child does not show up well in school because he is not able to take in, through one of the two major gateways, the significance of much that has to be impressed through this sense more or less exclusively. By all means, then, the young teacher must be on guard lest she unwittingly attribute mediocre or low performance in the schoolroom to mental inferiority, rather than to some physical deficiency, such as faulty hearing.

The hard-of-hearing child is handicapped in his language development. Being unable to hear distinctly, even the child whose deficiency in this respect is relatively slight lacks clear-cut auditory models after which to pattern his own speech, and in consequence may experience considerable difficulty in oral language. Those children in whom the aural deficiency is marked, of course, are much more handicapped. Never having heard spoken discourse clearly and easily, they are not only unable often to produce it fluently and smoothly, but cannot articulate and phonate the spoken word readily. The language of such individuals is often thick, indistinct, and poorly fashioned. Realizing their ineptitude in this respect, they are likely to avoid social situations in which conversation will be expected of them, thus closing one of the chief avenues of normal intercourse.

The hard-of-hearing child fatigues quickly. If you have ever been in a situation where you were trying to attend to a speaker whose voice failed to carry distinctly to where you were sitting, necessitating that you bend every effort to comprehend his speech, you can appreciate something of the mental fatigue which is engendered in the child to whom all the speech of the schoolroom comes thus faintly and inarticulately. Try as he will, he is unable to 'clear it up,' and only with the most persistent and continuous efforts can

he make out the tenor of the lesson, the story, the conversation, the discussion. It is hardly to be wondered at that the child of impaired hearing, lacking much of the will power and stimulus by which the grown-up can concentrate upon a half-audible lecture, is likely soon to grow weary of the mental strain required to comprehend what is poorly heard, and to turn his attention to some exercise less fatiguing.

The hard-of-hearing child is deprived of normal social development through play. The child who does not play — whatever be the cause — is losing out in his social evolution. The give-and-take of free play; the self-effacement and *esprit de corps* that result from it; the virtues of team-play, coöperation, and honesty engendered by it; the enthusiasms and interests arising out of it — in short, all those qualities of companionability and good sportsmanship that are fashioned in the breast of childhood through the life and ways of the playground — are indispensable assets in the growth and training of boys and girls who are to become our future citizens.

No one is less inclined to play than the child whose hearing is deficient; he is incapable of taking active part in the games and other play activities of the group, since he cannot understand quickly enough the part expected of him. In consequence of this known lack of spontaneity in action, the hard-of-hearing child not only refrains from venturing actively into the play group, but is even ignored or actually shunned by those children comprising it. Thus the deaf and partially deaf children become rather selfish than social in their attitudes and activities. Compelled more and more by the nature of their infirmity to abandon active membership of and participation in the group, they are thrown back upon themselves, and are extremely likely for that reason to become introspective, over-sensitive, and even morbid. Normal interchange of ideas is an important principle of

mental hygiene; abstention from play more perhaps than anything else in childhood restricts the opportunities for such interchange, and so makes for bad mental hygiene.

The hard-of-hearing child is likely to be misjudged by his parents. Henry was a ten-year-old boy of ordinary intelligence, but he was called 'heedless' by his father and mother, both of whom scolded and actually punished him frequently and severely for failing to do as he had been told to do, or for inattention when they were addressing him. In addition to being constantly in trouble with his parents, Henry did poor work in school, was chided by his teacher for being lazy and indifferent, and studiously shunned the companionship of other children. Consultations between the mother and the teacher confirmed both in the notion that Henry was a 'bright enough child,' but that he was heedless and self-willed. Things went from bad to worse, and Henry began to play truant in order to escape the odium of the schoolroom. To conceal this, he invented falsehoods and subterfuges. Finally he was taken to a habit clinic for examination and advice. The diagnosis revealed chronic adenoid infection, with involvement of the middle ear. With the consent of the parents, the adenoid tonsil was removed and clinical treatment provided for the ears. Within three months Henry was a new boy. This was quite to be expected, of course!

Henry is one of a multitudinous number of children that are constantly being misjudged by parents who, having no reason to suspect a physical cause back of 'heedlessness' in young children, ascribe it to some deficiency of will, or even of intelligence itself. No greater wrong could be done a child than this, for not only does it fail to remedy the difficulty in any way, but it actually tends to make the general psychological situation worse. Children who are thus censured and scolded by their parents become morose,

sullen, and deprecatory, losing much of their self-confidence and trust in themselves. The children are themselves ignorant in most cases, of course, of the low quality of their hearing, for they do not recall ever having heard any differently. Having no earlier standard by which to judge their present condition of hearing, they fail to realize the real nature of their dereliction, their alleged 'heedlessness,' and must perforce conclude that they are really not like other children. Conclusions of this sort, reached by young people, are, in the interests of sound mental hygiene, greatly to be regretted.

Some causes of ear trouble in children. Most ear trouble is localized in the middle ear; in fact, abnormal conditions of the outer and inner ear are so relatively rare as to be negligible for most teachers and school health workers. English health officers very commonly refer [1] unequivocally to *middle-ear disease* in their reports, implying thereby that from their viewpoint aural troubles and middle-ear troubles are one and the same. In America, our school examiners rather commonly apply to middle-ear infections the term *otitis media*.

We may classify the causes leading to otitis media under three headings, viz.: (1) infected tonsils and adenoids; (2) infective conditions resulting from the common children's diseases, notably measles, scarlet fever, and diphtheria; and (3) chronic naso-pharyngeal catarrh.

1. *Infected adenoids and tonsils.* We shall go into a more detailed discussion of the importance of diseased tonsils and adenoids in a later chapter. (See Chapter XII.) Suffice it here merely to anticipate by saying that not far from twenty per cent of the children in the schools have an infected nasopharynx, and that this condition represents by far the most

[1] See, for example, the *Annual Report of the Chief Medical Officer of the (English) Board of Education*, for the year 1923, p. 36 ff.

common cause of otitis media. The reason for this causative relationship between infected tonsils or adenoids, on the one hand, and a suppurating middle ear, on the other, may be readily appreciated when we reflect that the Eustachian tube which joins these two regions is very short (not in excess of two inches) in childhood, and fairly wide, so that it is very easy indeed for inflammation (i.e., microbic colonies) localized originally in the naso-pharynx, to spread upward along the mucous membrane and infect the middle ear. If the source of the infection be the adenoid, that body may and very commonly does become so enlarged that it obstructs the mouth of the Eustachian tube where it empties into the upper pharynx. In such case the mucus which is being continually secreted by the tube and middle-ear membrane cannot drain off into the throat, as it normally does, but is dammed up in the tympanum. Inflammation along the tube also may practically close it. This may result, in case the closure is long continued, in so disturbing the equilibrium of air pressure on both sides of the drum skin as to rupture it, producing a condition commonly known as 'running,' or discharging ears. Some two per cent of the school population are victims of chronic ear discharge. Again, if the dammed-in mucus contains pus, as is of course likely to be the case, there is always the dangerous possibility that the infection may spread to the mastoid region and attack the spongy walls of the temporal bone, producing the dreaded 'mastoids.' In any case, whether there be actual closure of the tube or not, an inflamed condition of the tube and middle ear usually means earache, with all its attendant head noises, cracklings, and other discomforts.

2. *Infective conditions resulting from the common children's diseases.* The layman is coming slowly to realize what the practitioner has long known and tried to teach him; namely, that the chief evil connected with the common diseases of

childhood lies not in the maladies themselves, but rather in their after-effects and complications. Rheumatism, nephritis, valvular disease of the heart, and pneumonia are among the graver sequelæ of attacks of these common diseases. Measles and scarlet fever notably carry in their train these and other serious after-effects, among which otitis media is one of the commonest. Thus, an analysis of 3684 cases of scarlet fever admitted to the Birmingham City Hospital, in 1921–22, disclosed the fact that some eight per cent either had on admission or developed during their stay in the hospital running ears on one or both sides. In the same city another investigator found that of 758 cases of scarlet fever in children under five years of age, 117, or 15.4 per cent, developed otitis. The Birmingham hospital even goes as far as to devote a separate ward to cases of scarlet fever with otitis media.

Measles is responsible for at least as many cases of otitis as is scarlet fever. Diphtheria is also quite frequently attended with inflammation of the middle ear. In fact, any of the respiratory diseases may cause a disturbance in this region and result in grave complications. "Even cold in the head," says Dr. Randall,[1] "tends to involve the ears, and while the recovery may seem complete, there is likely to be some unrelieved remnant of trouble insidiously but steadily increasing, and first one ear and then the other shows the decrease in hearing."

3. *Chronic naso-pharyngeal catarrh.* As Dr. Lee puts it,[2] catarrh is not in itself a disease, but merely a symptom of some abnormality in the mucous membrane of the nose and throat. In many persons these membranes are peculiarly delicate and sensitive, and are very easily irritated. Such disturbing agencies in the air as dust, smoke, pollen, and the

[1] In *Personal Hygiene*, by W. L. Pyle, p. 157.

[2] Lee, R. I.: *Health and Disease, Their Determining Factors*, p. 148.

like, may aggravate these tissues and so render them strongly susceptible to microbic invasion. This condition when chronic, regardless of whether or not associated with infected adenoids, not infrequently leads to an invasion of the Eustachian tube and so sets up otitis media. Most typically is this found to occur in children of the pre-school age.

Prevention of ear troubles in children. It has been conservatively estimated that about one third of all adults are deaf to a considerable degree in one or both ears. Obviously not all defects of hearing found in adults could have been prevented by due precautionary measures in childhood. It is true, however, that by far the greater number of grown-ups who suffer from acquired deafness must ascribe their handicap to ignorance and to neglect of proper care of the aural-respiratory tract in early life.

Not only does otitis media typically originate in childhood, but it is also found by the practitioner and school medical examiner to arise in a large proportion of cases in the pre-school period, and to be already well established at the beginning of school life. It is apparent, therefore, that any effective program of prevention of otitis must reach back to the earliest years, since it is then that tonsils and adenoids usually reveal infection, and it is in this period also that measles is particularly rife among children. Slowly our communities — especially the larger cities — are coming to appreciate the practical importance of infant welfare, and are making provisions for clinical and other welfare stations where mothers may procure both examination and advice, and even treatment for physical abnormalities found to be gaining a foothold in their babies and young children. Infected adenoids and tonsils, and inflammation of the middle ear, rank high among these abnormalities.

A special investigation [1] of 19,154 deaf and dumb who lost

[1] By Dr. J. E. Wallace-Wallin, in *The American Journal of School Hygiene*, September, 1920.

their hearing before the eighth year, and of partially deaf whose hearing became similarly affected before the eighth year, indicated that 7125 were less than twenty years of age, that 7541 were reported as congenital cases, while 9253 became affected during the first four years of life.

An important means of safeguarding children from middle-ear disease lies in systematically examining them for septic and catarrhal conditions of the mouth and naso-pharynx. This needs to be done occasionally in the pre-school period, at school entrance, and annually or oftener thereafter. There is no really good reason why a child's throat should not be examined as faithfully and as thoroughly as his achievement in arithmetic, or spelling, or handwriting. Septic teeth, tonsils, and adenoids cannot be discovered too early in a child's mouth, and once they have been discovered, treatment and correction cannot be too promptly provided.

Another preventive step may be taken in the interest of safeguarding the middle ear in the careful supervision of children during and subsequent to attacks of infective diseases, notably scarlet fever and measles. It is a significant fact that in England, where scarlet fever cases are ordinarily cared for in the hospitals, otitis rarely results; but measles, not ordinarily deemed of much importance, and treated usually at home, very commonly results in middle-ear involvement. In Austria, on the other hand, where measles is much more generally treated in hospitals, the number of cases of otitis among school children is comparatively small.

What is needful everywhere is for parents to realize that measles, scarlet fever, and other common respiratory diseases of childhood are dangerous, not so much in themselves as in the almost inevitable sequelæ that follow them in the form of complications or after-effects. Comprehending this

principle, they should understand the importance of medical or clinical examination, especially of the auro-naso-pharynx, subsequent to the apparent recovery of the child from the disease proper. Only thus can they hope to discover incipient inflammation in this region and check it before damage is done. If the examination reveals a sound condition of the membranes, well and good; if it reveals infection and inflammation, clinicians are able in most cases to treat the trouble successfully. With their modern methods of ionization, and of drying and sterilizing the tympanum and the Eustachian tube, physicians achieve complete cessation of discharging ears, earache, and otitis within a few weeks, provided they receive the cases in time.

A discharging ear is an extremely dangerous thing, and ought to be so regarded. Children coming to school with cotton carelessly stuffed in their ears, as they frequently do, should be at once referred by the teacher to the school nurse or physician; for this evidence should be taken as an indication that the parents are neglecting to procure proper treatment for a serious condition, and are endangering the child's hearing, as well as his health, by ignorantly endeavoring to absorb the discharge without finding and removing the cause.

Some indications of ear defects in children. In the following list are enumerated what teachers might well think of in a pupil as suspicious symptoms pointing to possible aural defect. Obviously none of them, with the exception of the first, is a certain indication either that a child has otitis media, or that his hearing is impaired. Each of them may and should, however, be looked upon with suspicion, and the teacher should test the hearing of any child found manifesting one or more of them, and refer him to the nurse or school physician for careful diagnosis and possible clinical recommendation.

The symptoms follow:

1. Discharging ears.
2. Saying "What?"
3. Inattention.
4. Seclusiveness.
5. Stupid appearance.
6. Mouth-breathing.
7. Torpor and dullness.
8. Catarrhal condition.
9. Frequent colds.
10. Tonsillitis.
11. Slow auditory comprehension.
12. Frequent misunderstanding of verbal directions, etc.

Special schools and classes for the deaf. There are estimated to be in the United States upwards of 60,000 totally deaf persons; of these, some 50 per cent owe their defect to heredity, the other half to neglect or accident. Approximately 20,000 children are included in this estimate. In England and Wales, Sir George Newman estimates (1923) that there are 4663 children who are totally deaf, and 1554 partially deaf. It is obvious, of course, that a careful distinction has to be made between those who are wholly deaf and those who are of various degrees of partial deafness. For the former, only special schools can suffice. For the latter, however, especially for those who can hear with only slight impairment, enrollment in the ordinary classes with normally hearing children is to be recommended. The social stimulation which comes to them from continual association with normal children more than offsets any special efforts which the teachers have to make in their behalf, such as careful placing of their desks, careful enunciation, etc. For those whose impairment is too great to permit of profitable enrollment in the regular classes, special classes need to be provided.

There are at the present time (1920 reports) in the United

to the school nurse, and by her communicated to the parents, referred to the clinic, or otherwise intelligently handled in the best interest of the subject.

A child who cannot hear the ticking of the watch at half the distance at which the average child can hear it will be somewhat handicapped in his school work unless care is taken to seat him in a favorable position in the front, and near the middle of the room. Assuming that the watch used is audible to the normal ear at a distance of four feet, children who are able to hear it not further than two feet should have special provision made for them in the way of seating. Those who can hear it only a few inches away, or only when it is brought in immediate juxtaposition with the pinna, will be gravely and severely handicapped in their routine school work, and some of them may need to be placed in special classes.

2. *The 'whisper method.'* Instead of using a watch the examiner may use nothing save his own voice, lowered to a whisper at the end of expiration. In such case, the directions provided by the Massachusetts State Department of Education, and reproduced below, are excellent ones to follow.

If it is possible, one person should make the examination for an entire school in order to insure an even method. The person selected should be one possessed of normal hearing, and preferably one who is acquainted with all of the children, the announcement of an examination often tending to inspire fear.

The examinations should be conducted in a room not less than 25 or 30 feet long, and situated in as quiet a place as possible. The floor should be marked off with parallel lines one foot apart. The child should sit in a revolving chair on the first space.

The examination should be made with the whispered or spoken voice: the child should repeat what he hears, and the distances at which words can be heard distinctly should be noted.

The examiner should attempt to form standards by testing persons of normal hearing at normal distances. In a still room the

standard whisper can be heard easily at 25 feet; the whisper of a low voice can be heard from 35 to 45 feet, and a loud voice from 45 to 60 feet.

The two ears should be tested separately.

The test words should consist of numbers, 1 to 100, and short sentences. It is best that but one pupil at a time be allowed in the room, to avoid imitation.

For the purpose of acquiring more definite information concerning the acuteness of hearing, one may have recourse to the 512 v.s. (vibrations per second) tuning fork and the Politzer acoumeter.

For very young children, a fair idea of the hearing may be obtained by picking out the backward or inattentive pupils and those that seem to watch the teacher's lips, placing them with their backs to the examiner, and asking them to perform some unusual movement of the hand, or other act.

Whichever test is used — the 'watch' or the 'whisper,' the purpose is always to discover those children whose hearing is relatively deficient, and not to determine absolute hearing acuity. The teacher is not a specialist in the latter art; it is her duty merely to determine roughly those among her pupils whose school work is likely to suffer because of defective hearing, and, having determined them, to give them every favorable opportunity and advantage within her control to get the most out of their school experience with the minimum of exhaustive auditory effort. Beyond this, aside from reporting her findings to the proper authorities, her responsibilities do not extend, although it is often found to be the case that when the school health authorities have failed in their efforts to convince a child's parents of the need of expert diagnosis and corrective treatment of a physical defect, the teacher is able to stimulate them to action.

Care of the ears. In addition to the general importance of careful treatment of colds and other respiratory diseases of childhood, as a means of conserving the normal functioning of one's auditory apparatus, there are several other precautions and safeguards which children should be taught to

observe in this connection. The first of these has to do with the proper cleansing of the external concha and meatus. The structure of the former is such that dirt and dust particles readily find lodgment in its folds, and unless they are regularly removed the condition becomes both unsightly and unhygienic. The meatus, as we saw earlier in this chapter, passes windingly inward to the drum-skin membrane, closing the entrance to the middle ear. This region is copiously provided with wax glands which secrete an abundance of sticky wax that helps to keep the passage flexible. When dust and dirt from the outside become mixed with this wax it tends to fall away in scales, which should be carefully removed from the outer end of the meatus with a soft towel. Much permanent harm is often done children's ears by mothers and nurses, who insert small objects, embedded in the end of a towel, cork-screw like, into the meatus in their zeal to cleanse the ears. There is extreme danger of puncturing the thin membrane in this way. The old adage: "Put nothing smaller than your elbow into your ears," is a hygienic one to observe.

A second hygienic precaution in the care of the ears has to do with protecting them from sudden concussions of air, as may occur from loud noises, shouting in one's ear, 'boxing' or striking over the ears, etc. The volume of air thus flung violently against the membrane may rupture it and cause deafness for life. Children and parents, too, must be brought to understand that the ear mechanism is every whit as complex, just as sensitive, and requires just as constant care to keep it functioning normally as does the eye, or any other delicately adjusted mechanism of the body.

TEACHING POINTS IN THIS LESSON

A. Structure and Function

1. The external ear.
2. The ear-drum.
3. The middle ear.
4. The cochlea.
5. How we hear.

B. Hygiene

1. Social value of efficient hearing.
2. Importance to normal hearing of a healthy naso-pharynx.
3. What 'middle-ear disease' really is.
4. Mastoid infections, and how to avoid them.
5. Common aural after-effects of scarlet fever, measles, etc.
6. Some indications of ear defects in our companions.
7. Social importance of special schools and classes for the deaf.
8. How and why the teacher frequently tests her children's hearing.
9. Simple precautions in caring for the ears.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Using the instructor's plaster model, make a careful study of the chief structures of the ear, endeavoring to locate and identify all of those described in the chapter.
2. Write out a comparative study of the registration of light waves upon the retinal nerves, and of sound waves upon the cochlear nerves.
3. Look up, in some good textbook of anatomy, a discussion of the structure and function of the semi-circular canals and the part played by them when one is performing such acts as spinning around in a swing, riding in an elevator, 'looping the loop,' or other unaccustomed bodily movements.
4. Compare the relative amount of deafness in your State with that reported by other States, and for the Country at large.
5. Recall any cases you may personally know of children whose hearing, once normal, has been impaired by one or another of the causes discussed in the chapter. Do you know any deaf adults? What is their story?
6. Make a study of the residential and day schools for the deaf in your State. What is their enrollment? What method of instruction is used?
7. With the assistance of a classmate, test the hearing of several children in the practice school, reporting your results in writing to the instructor.

8. Prepare an outline for a lesson on "Care of One's Ears," which you think might be given profitably to a sixth-grade class.

SELECTED REFERENCES

1. Burnham, W. H. *The Hygiene of the Ear.* In Monroe's *Cyclopedia of Education.*
2. Cornell, W. S. *Health and Medical Inspection of School Children,* pp. 290–304.
3. Pyle, W. L. *A Manual of Personal Hygiene,* section 4.

CHAPTER XII

CHILD HEALTH AND CARE

The problem of rearing healthy children. Who does not love a healthy, energetic, wideawake child? To be associated with him as parent, teacher, or playmate is a thing pleasant and satisfying in itself. Who, on the other hand, does not feel a bit resentful against somebody, a bit rebellious perhaps against society itself, at the spectacle of a sickly, pale, listless, or otherwise deficient child, robbed as it were of his birthright? For birthright it certainly is, or ought to be, that the childhood of every one be a time of general healthfulness as well as happiness. When the gospel of health has been preached and practiced far more effectively and universally than has yet been dreamed of; when indeed the biological millennium has been ushered in; it will have become one of the supreme purposes of human society to safeguard life at its source, and to guarantee to every child that basic biologic and physiologic soundness without which life in its broadest and fullest sense, liberty in its freest sense, and the pursuit of happiness in its noblest sense become mere empty phrases.

In the meantime we can but strive to do our utmost as teachers to be clever propagandists of health in our schoolrooms, and in our neighborhood and community, to the end that the children under our charge first, and after them the wider circle beyond the schoolroom, may be made sensitive and responsive to the new-old biologic gospel of health, which is after all the only real wealth, the only humanly achievable thing which money cannot buy, and which is therefore greater than it.

But the world still has a great way to go before the health and well-being of its children are raised to an even mediocre level. Our infant death-rate in America, as it is in most other countries, is inexcusably high, due to the ignorance of parents, to the demands made by an industrial age upon mothers who are often able to pause from their gainful extra-home occupations barely long enough to more than give birth to their children; and to the general social indifference to the whole hygienic problem of infancy and early childhood.

TABLE 10. SHOWING SOME INFANT MORTALITY COMPARISONS FOR VARIOUS CITIES

CITY	TOTAL DEATHS OF INFANTS UNDER 1 YEAR	INFANT MORTALITY RATE, PER 1000
New York	9666	75
Chicago	4850	85.5
Philadelphia	3338	82.1
Detroit	2271	87.6
Cleveland	1437	75.9
St. Louis	838	56.8
Boston	1720	92.7
Baltimore	1587	88.9
Los Angeles	991	71.96
Pittsburgh	1412	94.3
San Francisco	515	59.47
Milwaukee	822	80.44
Washington, D.C.	771	84.53

True, we now have baby clinics, health centers, feeding clinics, milk stations, and visiting nurses; but excellent and indispensable as these are, they fail to touch influentially more than the smallest percentage of homes into which children are born. The excellent results being achieved along this line, however, may be better appreciated when we stop to consider that in 1916 the infant mortality rate in the 55 cities in the United States, having a population in excess of 100,000, was 101 per 1000, while in 1921, in the same

cities, it had fallen to 90 per 1000. The intensive work in our larger cities is beginning to tell, although a darker side of the picture is presented by the fact that in 1920, in the United States, one mother died for every 135 babies born. "Baby week" programs and "children's year" campaigns are saving babies, if they are not saving mothers.

In the physical deficiencies found in the school child are reaped the fruits of infantile ignorance and neglect. School health workers in the schools of this country report 25 per cent of the children to have visual defects of some kind or other; 20 per cent to have diseased tonsils or adenoids, and to be mouth-breathers; upwards of 75 per cent to have diseased teeth or gums; 5 per cent to have discharging ears or other aural deficiencies; 10 per cent to have orthopedic defects, including spinal curvatures and flat-foot; 10 per cent and more to be seriously undernourished; that some 15 per cent have definite predisposition to tuberculosis, while more than 10,000 children die annually from this disease in the United States. These figures do not, of course, take into account the tens of thousands of children who succumb every year to the so-called children's diseases, or complications arising from them, and the hundreds of thousands more whose organisms suffer for years as a result of the toxins set free by these diseases, and the consequent weakness and susceptibility to further disease that go always with any malady.

The parental attitude toward health is surprisingly indifferent. It is difficult to conceive of a parent who would willfully neglect the health of his child to the point of placing life itself in jeopardy. It is doubtful whether even the most negligent parent would for a moment consent to destroy the future health of his child, or even to undermine it in any way. Yet the name of those parents is legion who are thoughtlessly doing exactly those harsh things by the atti-

tude which they habitually — almost instinctively — adopt toward the common-sense advice given them by school physicians, and nurses, and even teachers, with reference to preventive or corrective measures needed to be taken in the interest of the health and school progress of their children. A case or two in point will not be amiss.

C. is a boy nine years of age, in the second grade, which he is repeating this year. He suffers almost continually during the winter months from tonsillitis, which necessitates his being out of school from one to five sessions weekly. At the time when the writer examined C.'s throat, the infection of his right tonsil was so severe that pus droplets could actually be seen forming in the crypts. Consultation of the medical inspection records for the room revealed the fact that the school physician had noted down on the card twice each year the condition, and that the parents had been duly advised of the need of removal. The community maintained at that time no school nurse, and there was consequently no one to take the matter up personally with the home, save the teacher herself. Convinced of her clear duty in the case, the teacher had approached the father on the subject, and had by him been informed curtly that "children had no tonsils being ripped out" when he was a boy; that he had "never had anything of the kind"; that "all this talk about tonsils was sheer tomfoolery"; and that C. was "as well as anybody of his age was supposed to be," it being "natural for kids to have colds considerably." Here was a parent, no doubt as fond of his child as the average father, but who from ignorance and obstinacy was not only causing him to undergo needless present privation and unpleasantness, but was in all probability laying up for him future weakness and perchance illness and suffering.

M. is a boy of eleven, in the fourth grade, which he is repeating. It appears that during the first three grades the

child made reasonable progress, but during the past year has slumped very sharply in his school work. No intelligence tests have been given the children in this grade; the teacher, however, has no hesitation in pronouncing the child average in ability, but attributes his recent dereliction to inability to hear acutely or even moderately well. A watch-tick heard by the normal ear at two feet can only be detected by M. when the watch is brought within an inch or so of either ear. About a year since, M. had an attack of scarlet fever, which left him with middle-ear involvement. There is no clinic available for securing treatment, and if there were it is doubtful if M. would be permitted to attend it, since his parents maintain stoutly that there is nothing in the world the matter with the child's ears, and insist that he is merely 'heedless' — a trait which they appear on more than one occasion to have attempted to eradicate by corporal punishment. That their experiments have failed is attested by the circumstance that M.'s hearing is no better, if indeed it is not actually poorer, than it was six months ago. Here is another case where doubtless well-intentioned, but sadly uninformed parents, are systematically dooming a child to ultimate deafness, if to nothing less to be desired than that.

The attitude of teachers toward health is not sufficiently aggressive. It must be remembered that most of the teachers in actual service received their training at a period antecedent to the past ten years or so, when little emphasis was placed on the subject of health education. Whatever attitudes and viewpoints they may have developed in this regard during their professional training were limited more or less specifically to the evils of tobacco and alcohol, and to the anatomical structure and physiological processes of the organism. Consequently they have been at a distinct disadvantage in more recent years when it came to the actual teaching of *health*, and to the fostering in boys and girls of

those habits and attitudes toward health which modern hygiene expects of them.

But if our teachers have not been trained to be missionaries and advocates of the gospel of health, they have certainly been trained in the technique of the now much expanded three R's, which fact has tended again to make them excellent teachers of formal subjects but poor exponents and proponents of educational hygiene. Enthused by and devoted to the former, they have been in grave danger of overlooking the latter. Teachers of subjects, they have not always been nor always are teachers of *life* and *life adjustments* through the medium and approach offered by hygiene. In consequence of this educational asymmetry and loss of perspective, we are teaching classes under a thermometer registering 75° F., or higher; in an atmosphere all but saturated with humidity; with windows closed; with children uncomfortably seated in maladjusted chairs, at maladjusted desks; in all types of unhygienic posture, with books held at unhygienic distances from the eyes, etc. We are teaching them how to measure linear surfaces, but not how to weigh and measure themselves; to draw straight lines, but not to build straight backs; to strike trial balances, but not to strike for balanced foods; to spell handkerchief, but not to use it; to keep their desks clean, but not to bathe and cleanse their bodies; to avoid whispering, but not to avoid sneezing, coughing, and breathing in one another's faces; to think deeply, but not to breathe deeply; to preserve open minds, but not open windows; to present clean papers, but not to insist on clean streets; to speak pure English, but not to drink pure milk; to appreciate the products of Brazil, but not the products of hygienic living; to classify lepidoptera, but not foods; to exercise their minds, but not their muscles. Our emphasis, in short, has been rather upon the intellect than upon the body machine which subtends and conditions it.

All this is fortunately changing — though all too slowly. When aggressive school authorities, as wise as they are determined, grant to the subject of health in the curriculum at least equal importance with that of arithmetic; and when teachers are trained to teach the latter no more cleverly than they are the former; and when they have at their disposal the time and equipment, and the spirit, that are indispensable — then there will be a rebirth of hygiene not unlike that practiced and taught in the schools of the ancient Greeks. To be forerunners of such a humanistic movement in the domain of hygiene and public health is to be the high privilege and responsibility of the teacher of to-morrow.

Society is too lax in this regard. In any age the practices of the schoolroom reflect more or less exactly the spirit and ideals of the time. Thus, it follows easily from the preceding discussion that society as at present constituted is not over-interested in this vitally important matter of health education, notwithstanding the immense impetus given to the whole movement by the disturbing revelations of the selective service examinations of 1917–18, in which it was disclosed that a third of our youth in the prime of life were too unsound physically to make acceptable soldiers. Society is after all but a collection of individuals, and so long as any large number of individuals either have no interest in or actually oppose school health work, attempts to popularize and extend it among the schools cannot be altogether successful.

There is no doubt but that most of the opposition to health education is purely passive; society is little interested, has no time to give to a consideration of its importance; and is content to follow a *laissez-faire* policy with respect to it. Opposition of this sort — if one may call it opposition — is neither insurmountable nor dangerous, although it necessitates the expenditure of correspondingly greater effort on the

part of leaders and promoters of this work to counteract it. It is unfortunately true, however, that some individuals go so far as to bind themselves together into leagues and societies for the avowed purpose of conducting propaganda against much of the approved school health work — notably that done by the school physicians and nurses. In the author's files at the present moment, for example, is a letter of remonstrance, written on stationery imposingly embossed with the name of such a society, and below it the explanatory statement: "An Organization Designed to Keep Physicians out of the Schoolroom." (!) Uninformed parents, who would otherwise not be opposed to health inspection, are quite naturally misled by the activities of such organizations as these, and become often vigorous, if ignorant, opposers. Leaders in school health work are considerably annoyed and mildly inconvenienced in some communities by the activities of otherwise good citizens who are thus misled. In a later chapter (see Chapter 17), we shall go more specifically into this matter of health inspection.

Careful avoidance of disease is always to be desired. Not long since an epidemic of measles broke out in a boys' preparatory school; some 40 per cent of the students contracted the disease. Throughout the community people smiled and remarked humorously upon the circumstance of boys, in their middle teens, having measles — "that baby's disease, you know!" Nobody — save doubtless the boys themselves — took the matter seriously, since "measles amount to nothing anyway," as people remarked wisely, turning thence to a more important topic of conversation, say, for example, the weather.

This incident represents fairly the naïve opinion of the layman. Most people are inclined to discount the dangers arising from common ailments, the fact that a disease is common being *prima facie* an indication of its inconsequence.

Nothing could be farther from the fact of the matter. Every ailment is either serious in itself, or in its possible complications, and the sooner people begin to take care of incipient colds, sore throats, rheumatic twinges, etc., the sooner will the expense and suffering attendant upon long periods of illness and overwork be profoundly reduced. Similarly, the sooner individuals stop exposing themselves needlessly to disease, and learn to take care of their human machines, as they do, for instance, of the nickel on their automobiles, the sooner influenza, diabetes, pneumonia, and tuberculosis — to mention but a few of the more dread present scourges of mankind — will dwindle to respectable proportions.

Heart disease a case in point. Just by way of illustration of the weakening effects of disease upon the organism, let us consider the status of the modern heart, disease and failure of which to-day head the list of causes of death. Of all the organs in the body, the heart is unquestionably the one most likely to be involved whenever disease attacks the organism at any point. In a very true sense the heart bears the brunt of dental and naso-pharyngeal infections, of rheumatic fever, of measles, scarlet fever, diphtheria, and the other children's diseases, as well as the more specifically adult diseases. The reason for this inevitable causal relationship between diseases, on the one hand, and the weakening of the heart, on the other, is not far to seek. The toxins thrown into the blood by disease are passed and repassed scores of times a day through the valves and chambers of the heart, as well as throughout the blood tubes. The presence in the blood of these irritants very easily and very commonly results in damaging the heart-pump — oftentimes irreparably. There is no question but that a large percentage of the cases of heart disease which develop in middle life are traceable directly back to the weakening after-effects of some disease or defect suffered in childhood.

In a recent popular book,[1] Dr. S. Calvin Smith has gone at some length into this important subject. With reference to the diseases of childhood, he says:

> Those who saw the prostrating effects of measles among adults in war-time hospitals conceived a deep respect for this "innocent" disease, and marveled at the natural inherent strength of childhood that can so often pass through measles with so little immediate inconvenience. When the ears discharge, or when pneumonia develops either during or as a consequence of measles, the heart is likely to give evidences of struggle with the new invasions, and if they are severe the heart may be damaged in later life.

Of diphtheria, he adds:

> Diphtheria is a notorious heart-wrecker in childhood. Twenty-two per cent of the children affected with this disease develop heart conditions; of these, many recover from the immediate heart involvement, only to show an aftermath later in life in hearts that are less efficient than they should be. The immediate peril in diphtheria is heart paralysis — striking as suddenly as a bolt of lightning from the clearing skies of approaching recovery — after the heart has borne the brunt of the blackened storm, after the youngster has recovered sufficiently to smile from the pillow and take an interest in toys again. . . .

It must not, of course, be concluded from the above paragraphs that heart involvement is the only complication likely to follow the diseases and defects of childhood. The lungs, kidneys, and other important organs are co-sufferers with the heart, and any impairment of the former at once puts added strain upon the latter. It is essential in the interest of vigor, health, and longevity that human beings guard themselves from the entry of disease germs into their organisms as carefully and persistently as they are able, since every microbe growing in the body means present illness, greater susceptibility to the entrance of other varieties, and a wear and tear upon the vital organs which may seri-

[1] Smith, S. Calvin: *How Is Your Heart?* pp. 65 ff. Reprinted by permission of Boni and Liveright, Publishers.

ously injure and disable them, destroying their efficiency and cutting off life prematurely.

Willful exposure of children to disease. "I want my Henry to take all the diseases a-going while he is young, so he won't have to bother with them when he gets older!" Who has not heard uninformed parents voice this inspired philosophy? As if, forsooth, every one was doomed to have "all the diseases a-going" sooner or later, anyway! As a matter of fact, the so-called children's diseases are children's diseases primarily, and while occasionally adults take them, they do so relatively rarely. By reason of the low germicidal power of his white corpuscles, and his general weak powers of resistance, the younger a child is the more likely he is to contract a disease. Every day that the taking of a disease can be postponed means the growth in the child of an added reservoir of resistance, and the lessened probability of his taking it at all. There are children who grow up without ever having more than one, and even without having had any of the children's diseases. There are others who have them all, or nearly all. There is no question about the former's better chances of adult healthfulness than the latter's. Parents should do all in their power to keep damaging microbes from the bodies of their children, partly for the reason mentioned, and partly because every disease is distinctly dangerous and has a mortality rate. Moreover, as we have seen, once a child's resistance power has been depleted by, say, measles, the more likely he is to contract scarlet fever, or diphtheria, or some other malady to which he may be exposed. Nor does the fact that one has had a disease once render him thereafter immune to the same disease, as is popularly supposed. The chances are less that he will contract it subsequently, but there is no guarantee.

Importance of a thorough health examination at school entrance. This is a phase of real educational procedure that

we in America have not yet studied sufficiently. It is interesting to note, however, that in England and on the Continent — from which places we have largely received all example and precept for educational hygiene in this country — there have been in operation for several years various plans for beginning health training in earliest infancy, rather than to wait for entrance to school. So far in America our line of effort in this direction has lain chiefly in the establishing of baby-weighing centers and milk stations where parents might buy pure milk for their babies, or where they might receive expert advice, from nurses or philanthropic citizens in charge, in the bringing-up of their infants to be physically sound. As communities, however, we have done practically nothing to promote the health of children between one year of age and the time of their entering school.

It is a fact well established in the English investigations, as well as in the German, that it is not until the second year of life that incipient defects begin to make their appearance, and that preventive measures taken during the first year tend rather to insure that the infant shall live to grow up than that it shall be subsequently free from physical disorder.

Dr. David Forsyth, physician to the Evelina Hospital for sick children in London, called attention several years ago [1] to "the widespread physical deterioration that overtakes children during the first four or five years of life," and concluded that "the conditions cannot adequately be met by postponing action until the children reach the minimum school age, by which time much suffering and not a little permanent damage will have been inflicted."

The city of Westminster, England, in 1912, opened a medical inspection center for children under school age which, through the coöperation of the public health au-

[1] In *Pediatrics*, 1913.

thorities and with the help of a staff of health visitors, was able to get into touch with every family into which a new child was born. As was designed, the center very soon had under observation the entire under-school-age population of the district, the aim being to keep every child under medical supervision from the time of its birth until the end of its fifth year, and then "to hand it over sound and healthy to the school authorities, together with the medical record of the material facts in its life for the school doctor."

To quote further from Dr. Forsyth's paper:

> ... Altogether 374 children have been examined, excluding reinspections. Of these 131 were under one year of age, 77 under two years, 83, 50, and 33 under 3, 4, and 5, years, respectively. The outstanding feature of an analysis of the material record cards is the rapid rise in the tide of disease with each year of life. For, while the large majority of the children in the first period are found to be healthy, only a small minority come through to their fifth year without some physical defect of some kind or other. This is most strikingly seen in cases of dental caries, a condition which is probably responsible for more ill-health among children than any other. The increasing percentage of these cases in successive years is shown in the table below. It should further be added that, as a rule, the more advanced the age, the more extensive was the disease. A very similar rise is seen both with enlarged tonsils and adenoids, while the proportion of these cases in urgent need of surgical operation increases yearly, indicating of course, the aggravation of the condition when left untreated. With rickets, on the other hand, the incidence reaches the maximum in the second year, thereafter rapidly declining; this disease, therefore, so often the cause of lifelong deformity has inflicted its damage long before school age.
>
> Altogether the 374 children presented 332 defects. In addition, the feeding of a large proportion of the cases in the earliest years required some modification, great or small, and, in almost one half of the cases under one year old, needed revision in one way or another. The table following, showing the percentage of children affected in each year, summarizes the incidence of the most important defects.

TABLE 11. PHYSICAL DEFECTS OF 374 CHILDREN EXAMINED, BY AGES

	UNDER 1 YEAR	1 YEAR	2 YEARS	3 YEARS	4 YEARS
Teeth		2.6	18.1	34.0	63.6
Tonsils		7.8	16.9	24.0	26.9
Adenoids	1.5	10.4	22.9	38.0	33.3
Rickets	13.0	25.9	9.6	8.0	3.0
Diet modified	49.6	22.8	6.0		

The practical conclusion from the point of view of prevention and curative treatment hardly needs stating. Suffice it to say, there is no reason to suppose that the children examined at the center differ materially from the other children of their class, at any rate in urban areas, and it is highly probable that, as similar centers are organized elsewhere, the results will be, in the main, similar to those in Westminster. In other words, large numbers of children, healthy in all respects at birth, become within five years the physically defective entrants whom the educational authority is required at no small cost to restore, so far as possible, to their original state of health. Yet most of these cases are preventable, or, if taken in time, can be remedied more speedily, and therefore more cheaply, than if taken at school age, by which time not a few will have received permanent damage — physical or mental. The problem of the defective child largely resolves itself into the problem of the under-school-age child, and seems hardly likely to be solved by any scheme short of a national one insuring to all children regular supervision from birth to school age. And this, to be fully successful, must run side by side with educational measures for instructing the mothers themselves who, from ignorance far more than from wilful neglect or even from indigence, are unable to safeguard their children's health.

In general those defects which, according to the findings of such investigators as Forsyth and Winch in England, and Thiele and Steinhaus in Germany, have already fastened themselves upon pre-school children include diseased conditions of the teeth; enlarged faucal and adenoid tonsils; rickets and other complications arising from malnutrition; myopia; hardness of hearing resulting from various throat

affections, and pre-tubercular symptoms, all of which defects, as every physician knows, are easily remedied if taken in time. A thorough physical examination at school entrance would discover the presence of any of these, and thus determine the exact condition of the child's health and his ability to enter on the work of the school. "What," asks Dr. Burnham, "could be more inefficient than our present haphazard method of beginning school work without determining whether or not pupils are fit for school occupations?" Dr. Burnham would go further than the mere physical examination, and have the survey include not only the physical condition of the child, but would also have it embrace a test for mental age, thus determining whether the child is of average age to start with, or whether far below it — or perchance well above it. The future problems of placement in the grades or in special classes would thus be partially solved at the very beginning of school life. If need be, Dr. Burnham would recommend a sort of health year for beginners, in which chief if not entire emphasis would be laid upon the physical improvement of defective children as the only foundation upon which the real work of the school may be safely built.

The school not to blame. It is, then, undoubtedly true that instead of blaming the school for the alarming amount of disease and defect to be found increasingly up through the grades, we have none to blame but ourselves and our failure to start soon enough in our campaign of child conservation. In the past we have been content to allow every child at the completion of his sixth year to enter school, utterly regardless of physiological age and physical fitness. Then, not only have we found physically handicapped children in every grade in our schools, but the authorities have reported year after year percentages of retardation often as high as fifteen per cent. Essentially speaking, the term 'retarded

pupil' in a grade should be a misnomer, for with proper initial school-entrance examinations, both physical and psychological, it should be possible at the outset to place children almost without exception in the proper grade, school, and class. Children mentally or physically inferior would be weeded out, and either placed in corrective classes, or else in special classes for fixed defectives. The perennial drag upon our school system of thousands of these unfits has reached a point where reform is becoming essential. Either discover, diagnose, and correct the physical irregularities which inevitably predispose them to the backward, retarded group, or else, if correction is impossible, put them into specialized classes. Most cities now conduct these special classes, but it is an unfortunate fact that, under their present organization, they often fail to include among their numbers all, or even nearly all, children of similar limited capacity to be found in the school systems. It is doubtless also true that they include not infrequently scores whose physical disability might have been overcome if taken in time, and who should now be doing good work in regular classes. The present waste of time and effort on the part of grade teachers, about whose necks hang these educational millstones, is enormous. The whole work of the school is hampered by the presence in it of those children who, because of mental inferiority, should never have been permitted to enter, and by that of those whose bodily condition should first have been carefully diagnosed and ameliorated.

In training for the pursuits of war, such lax methods of organization would not be countenanced. Here original selections are rigorous; characteristics meriting promotion must be positive; rejects must spend a period in the fields in order to bring their health up to an established minimum; and men obviously below the standard are placed in special limited service. The great mass are sufficiently sound to

begin drilling at once. Applied to the schools, the same business methods would require the examination rigorously of all applicants for entry to school; would reject temporarily those physically inferior; would reject unconditionally those obviously unable to do the work of the school, and place them in special classes; while the great mass would be admitted without question to the schools as satisfactory beginners.

Is there any good reason why we should be more strictly business-like in making soldiers than we should in making citizens; or in building up a military machine than in building up a civic machine? Efficiency in the one is not less essential than efficiency in the other.

But it is not enough that we subject every child upon the completion of his pre-school life to a rigorous health examination, for defects and infirmities are often so fixed in children by that time that they either fail entirely to respond to corrective treatment, or, as in most cases, they respond very slowly, and as a consequence children thus physically unsound are handicapped in their school work throughout the entire first year or more of attendance. Psychologists have pointed out long since the extraordinary mental and physical strain which the unaccustomed life and surroundings of the school cause children to undergo during the first few months in which they are striving to make the necessary adjustments. Even for the most robust and capable child, the curve of growth often follows a plateau level during the first year of school life, so new and strange are the stimuli pouring in upon him. Consequently the nervous system of every child should be fortified to withstand the new experiences of school life and school influence. In order to guarantee such an optimum physical condition, it is an unwise policy which bids us wait even until the time of entrance before examining carefully the health of the prospective pupil.

Some common defects of childhood. Under this caption we shall consider, in order, the following common physical deficiencies of childhood, and the care and treatment needed in the case of each: dental defects; diseased tonsils and adenoids; malnutrition; and enlarged glands. Under a later caption we shall consider specifically the children's diseases.

1. *Dental defects and infections.* We have already studied the dental structures (see Chapter IX). It remains at this point to discuss the common defects and general hygiene of the teeth. The problem of the relationship of the condition of the teeth to that of the organism in general has been at least partially solved in recent years by the clinical evidence furnished in institutions and infirmaries everywhere. This evidence appears abundantly to corroborate the theory of focal infection; i.e., that pus in a structure like a tooth or a tonsil is absorbed into the blood and by it distributed throughout the body to attack the point of least resistance in the system. In some persons this point is the heart; in others, it is the joints, giving rise to rheumatism; in others, it is the kidneys; in still others, it may be the digestive tract, or the eyes, or the arteries, or the nerves, or perhaps even the appendix. One of the first questions physicians are asking their patients nowadays is: "How are your teeth?" And certainly some very remarkable cures have speedily followed the removal of infected teeth.

It must be confessed, on the other hand, that many persons have been persuaded to sacrifice teeth which the X-ray showed to be infected, without manifesting any general improvement in their health. It is also true that many individuals have grossly neglected and even ugly teeth, and yet enjoy excellent health. Neither of these circumstances can be interpreted, however, as destroying the theory of focal infection. The condition secondary to the dental infection may be advanced so far that removal of the primary cause

avails nothing, as, for example, when the tissues of a joint in the case of arthritis have been already destroyed before the draining of pus pockets under the teeth is brought about by dental extraction or operation. The general principle may probably be laid down that pus is never safe to have in any part of the body, and common sense should dictate its removal whenever and wherever it is found.

Writing recently in *The Commonhealth*, Dr. Leroy Miner puts the matter of teeth and health in the following words: [1]

> In the light of our present knowledge, if the individual appears to be in vigorous health, conservative measures are warranted; but if the individual is suffering from any of the serious systemic diseases in which pus plays a part, radical measures that will insure prompt and thorough elimination of dental infection are not only justified but imperative.
>
> This does not mean, however, that teeth should be ruthlessly sacrificed on snap judgment. Careful diagnosis of the condition of the teeth from clinical and X-ray examination should not only be made, but search for infection elsewhere in the body, especially in those structures that are frequently the site of infection, such as the tonsils, is desirable. Then, with all the facts at hand, a more accurate decision can be made as to where the trouble is located and what treatment is necessary for relief. . . . As for the present, while we must protest against the unnecessary sacrifice of teeth, we must not neglect the fact that dental infection may result in even more serious consequences, and, if it comes to a choice between doubtful teeth and any vital organ, such teeth should be eliminated.

2. *Dental caries.* This is by all odds the great American disease, it being found in a progressing stage in the mouths of ninety per cent or more of our school children. It is not an uncommon occurrence for health inspectors to report not a single child in an entire room having excellent and well-cared for teeth, free from decay. Table 12 indicates the results of

[1] *Monthly Bulletin of the Massachusetts State Department of Public Health,* September–October, 1920, pp. 295–96.

a survey of two grades in the same building, made by the author to determine the condition of the teeth of primary children in a certain congested neighborhood:

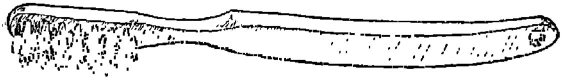
TABLE 12. SHOWING THE NUMBER OF CARIOUS TEETH IN TWO PRIMARY GRADES

CHILD NO.	GRADE 1	GRADE 3
1	0	2
2	0	5
3	0	3
4	8	8
5	0	0
6	4	0
7	8	3
8	12	5
9	11	5
10	10	4
11	7	3
12	0	4
13	2	0
14	6	2
15	5	2
16	0	2
17	0	2
18	0	4
19	5	6
20	12	0
21	12	2
22	0	6
23	0	5
24		6
25		8
26		6
27		1
28		4
29		3
30		6
31		10
32		2
33		4
Total	102	123
Average per child	4.4	3.7

Dental caries leads to three deleterious systemic effects in the child afflicted: (1) a crippled chewing apparatus; (2) cavity pockets within the dentine, which furnish ideal incubators for the proliferation of bacteria, millions of which hatch unmolested daily, mix with food, and are swallowed; and (3) abscesses or pus pockets at the tip of tooth roots, which are constantly under inflammatory pressure, and whose contents are readily absorbed into the blood. It has been estimated that eighty per cent of all dental disease may be prevented by proper home care of the mouth and regular consultation of the dentist twice a year for prophylactic and preventive treatment.

Many State and municipal health departments prepare and circulate attractive little brochures, giving to children and parents the chief facts they need to know about their teeth, and suggestions for keeping them healthy and sound. Figure 79 represents a little card furnished to school children by the hygiene division of the Massachusetts Department of Public Health. Similarly, Figure 80 presents a few illustrations taken from a folder on "Instructions for the Home Care of the Mouth," prepared by the Board of Health of Bridgeport, Connecticut. Appropriate text accompanies these and other illustrations found in the folder.

Irregular or impacted teeth are also very commonly met with in children; indeed crooked teeth are likely to be the rule rather than the exception. This condition is usually due to a failure of the bones of the face to grow large enough, or in the right direction, to support the teeth in the correct position. Anything therefore that restricts or impedes body growth in general is reflected in the nutrition of the facial bones, and may cause crooked teeth. Among other causes of this dental defect may be mentioned thumb-sucking, neglect of the temporary teeth, since loss of one tooth deprives the adjacent teeth of the support they need to keep the



Instructions for Home Care of the Mouth

BRUSH the teeth before breakfast, after each meal, and before going to bed.

BRUSH with warm water, using tooth powder or tooth paste at least once a day.

BRUSH at least two minutes each time, using an up and down stroke.

BRUSH the gums and roof of the mouth, as well as the teeth.

BRUSH the teeth carefully; then pass floss silk between them to remove any remaining food. Rinse the mouth well.

BRUSH should be rinsed well after using and kept for your personal use only.

BRUSH should have saw-shaped edge and should never be used after it becomes soiled or when the bristles become separated or matted.

BRUSH your teeth and keep away decay.

Massachusetts Department of Public Health
Division of Hygiene

Fig. 79

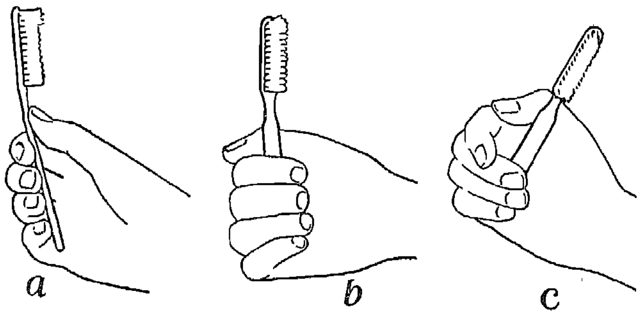


Fig. 80

(a) Hold of brush for left side. (b) Hold of brush for right side. (c) Hold of brush for inside of lower teeth and gums.

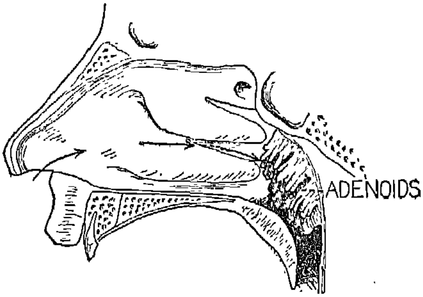
From a pamphlet published by the Board of Health, Bridgeport, Conn.

curved arch intact, so that they drift out of their proper position; and mouth-breathing, which eventuates in narrow jaws, narrow nostrils, and a high palate. Orthodontists are usually able to correct irregular teeth in children by means of clamps, provided remedial treatment is started early enough. Uncorrected, this condition results commonly in a nervous irritation which may appear merely as irritability and restlessness, or it may take the form of St. Vitus' dance, or some other severe nervous indisposition.

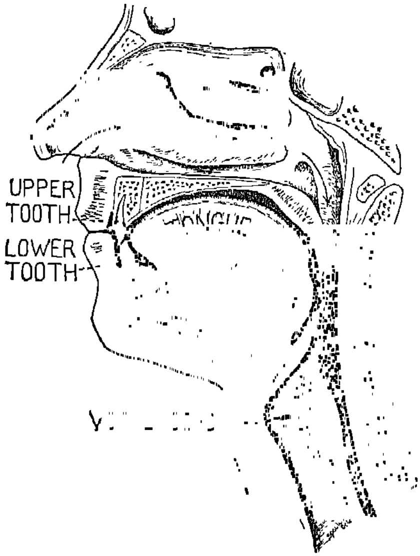
3. *Pyorrhœa.* Still another common dental disease is *pyorrhœa*, commonly called *Riggs Disease*, which results in a loosening of the teeth from the gums. The yellowish tartar deposit tends to settle about the neck of the teeth, especially those in the lower jaw. If not carefully removed occasionally by the dentist, and regularly cleaned away with brush and dental floss by the owner, this deposit tends to set up bacterial action between the gum and the teeth. This means not only loosening but also more or less destruction of the tooth, since the bacteria pass thus easily below the gum and attack it from underneath. Starting ordinarily from the front teeth in the lower jaw, pyorrhœa spreads rapidly throughout the whole set, and even upward to the upper teeth.

Diseased naso-pharynx. We have already referred in a previous lesson to the relationship between infected tonsils and adenoids, and otitis media. Let us here refer briefly to the development of these structures. The faucal tonsils, two in number, are located on either side of the root of the tongue, and may be plainly seen in healthy children as small, oval bodies thrown out from the side of the throat. The adenoid tonsil, or third tonsil, is situated directly back of the soft palate, near the entrance to the nasal passages. Both the faucal and nasal tonsils are believed to be component elements in Nature's protective mechanism, possess-

ing the supposed function of arresting the entrance of disease germs into the body. If this was Nature's plan, she certainly was not so foresighted as she might have been, for instead of acting as guardians of the health, they become all too often themselves infected by the very microbes they would destroy, and develop into prolific points of entry to the body for such affections as tonsillitis, arthritis, heart disease, etc.



A passage blocked by adenoids



A clear passage to the Lungs

Follow the arrows.

FIG. 81

While it is true that, lymphoid as they are, the tonsils are quite likely to be hypertrophied in childhood, it is undoubtedly the case that when much enlarged they are likely also to be diseased; especially is this true in the case of the adenoid tonsil. When diseased, tonsils are overgrown, and their surface is more or less covered with

cryptic areas and canals containing pus, ferments, and germs. In such cases they should be removed by a skillful practitioner, and when thoroughly deleted they do not return subsequently. It is only when some small bit of their substance is left that they reappear after a few months.

In addition to their direct physical effect upon the health of the child, in the form of mouth-breathing, irregular teeth, easy addiction to colds, tonsillitis, and the respiratory diseases, malnutrition, arthritis, etc., diseased tonsils and adenoids also very radically affect the ability of the child to do his school work creditably. Much of the retardation in our schools may without question be laid at their door. The effect of chronic absorption of toxic materials from these areas into the blood stream is obviously to debilitate the cells of the body, which are thus considerably incapacitated in their ability to assimilate food. The brain cells share of course in this limitation, and the mental powers suffer in consequence. The pupil with a diseased naso-pharynx is likely to be backward, slow, ambitionless, nervous, and generally below par, both mentally and physically. There is good evidence to suspect also that his moral nature is in some danger of inundation.

Teachers should coöperate to the fullest extent with the health workers in securing corrective treatment for such cases of diseased tonsils or adenoids as are demonstrated to be in need of it. Among the indications of probable tonsillar or adenoid infection may be mentioned the following:

Chronic addiction to colds.
Frequent tonsillitis.
Mouth-breathing and nasal speech.
Stupid facial expression.
High, arched palate.
Irregular teeth.
Ear or glandular symptoms.
Low vitality.
Mental apathy.

Whenever a child manifests one or more of these symptoms, the teacher is justified in suspecting the presence of diseased tonsils or adenoids, and should refer him to the physician or nurse for careful examination of the naso-pharynx.

Enlarged glands. The *cervical glands*, lying in the neck, are quite commonly found to be enlarged and diseased in childhood. Swollen cervical glands are often tubercular; indeed, the glandular type of tuberculosis is the one most usually found in children of school age. Only a very small number of children have pulmonary tuberculosis, as indicated by the presence of bacilli in the sputum, for the simple reason that pulmonary tuberculosis runs its course quickly in the young, and they are usually too ill to attend school. Inasmuch as the bacilli are encapsuled within the glands in this typically childhood form of tuberculosis, they do not escape into the throat to be expelled in the breath and become a menace to the health of others, but remain imprisoned within the glandular tissues, there performing their work of destruction. While glandular tuberculosis is not thus spread to others, it is contracted originally of course from some one who has the pulmonary form. Hence the importance of safeguarding children from an environment in which there are consumptive individuals. When admitted into the bodies of healthy, robust children, the bacilli of tuberculosis ordinarily die before permanent harm is done; in children who are malnourished, however, or who are debilitated by the effects of such diseases as scarlet fever, measles, diphtheria, whooping cough, etc., they find an excellent breeding-ground, since the blood is abnormally low in its germicidal and oxygen-carrying powers.

From this discussion, it is not to be concluded that enlarged neck glands are always tubercular; they are not, any more than enlarged tonsils or adenoids are always infected.

When they are swollen, however, there is always the easy possibility that tubercle bacilli may be present in them, and children thus attacked need good medical or clinical attention, as well as the best possible environmental conditions in order to build up their body resistance and so halt the advance of the bacilli.

Life is metabolism. From a strictly physiologic point of view, the daily program of living is completed when the requisite and proper food has been taken into the digestive tract, assimilated, and presented to the cells, and the resulting katabolic products of oxidation collected and excreted, together with the storage in the liver and other warehouse cells of the excess amounts of fats and sugars. Beyond this program the daily metabolic processes of the human body do not proceed. In order to insure the carrying-out of the program to perfection and with the minimum strain upon the internal organs of assimilation and digestion, however, it is essential in the first place that a sufficient amount of food be taken, and, in the second, that the right kinds be properly balanced. Malnutrition, or the starvation of the cells of the organism, may be due to one of two causes: (1) insufficient food, or (2) improper food. Theoretically, at least, an organism might be surfeited with food, yet die of starvation of the cells. Actually, however, cell starvation when due to improper foods comes about remotely, or indirectly, through the complications offered by a weakened resistance power to disease, or a general intestinal toxemia which destroys the entire nutritional process, and so life.

In the case of the child in the midst of the growth impulse, any interference with normal and optimum nutrition is both immediate and disastrous. If life for the adult organism is metabolism, it is triply so for the child. One has but to cast about him to see innumerable victims of metabolic interference. The emaciated face and limbs; the dull, listless ex-

pression; the stunted development of muscle and the often dwarfed development of bone, all point to the condition of cellular starvation, either direct or remote. Such children belong often no more to the poorer or more ignorant classes than to the well-to-do and intelligent, although it is of course a fact that on the whole the malnourished child in any school system comes from the poorer type of home. There are varying degrees of malnutrition, from the child whose vigor is seriously threatened by carbohydrate excesses, through the child who is actually getting an insufficient amount of nutriment from his dietary, to the child who presents the tell-tale symptoms of extreme cell starvation. Normal growth and a normal rate of development physically presupposes and depends upon normal metabolism. Even in the case of disease, defect, or illness of any sort, it is probable that the ultimate underlying causation is an interference in and derangement of the process of metabolism, or its allied processes. Thus the health and happiness of the child may depend directly upon his dietary, and when one considers the naturally low resistance power of children to disease, the tremendous importance of a proper and properly balanced dietary is much enhanced.

Undernourished children. In 1909, Sill found[1] upon careful medical diagnosis of one thousand children (ranging from six to twelve years of age) at his clinic on the lower East Side of New York City, that four hundred of them were badly undernourished. This sounds not unlike the testimony given eight years later by Bowers,[2] who quotes a New York physician to the effect that "my six hundred and fifty rejections out of a total of fifteen hundred examined simply reflects the condition of poverty in my district. It

[1] Sill, E. Mather: "A Study of Malnutrition in the School Child," in *Journal American Medical Association*, vol. 52, no. 25, p. 1981.

[2] Bowers, Edwin F.: in *Everybody's Magazine*, 1917.

is safe to say that forty per cent of the young men on the East Side are unfit for military duty because of the lack of proper nourishment, and the lack of clinics to minister to their needs." As ye sow, so shall ye reap; nutritional want in the child spells nutritional want in the conscript.

Sill points to a serious fact when he declares that many of the children from the poorer districts no longer possess the desire for good food. Their stomachs are in such a condition that good food will not be retained in them at first. The stomach is so used to tea, coffee, etc., that it has actually to be educated by degrees to a stronger, wholesome diet, much as one might train a muscle! Dr. Sill concludes that it is not poverty primarily that is responsible for malnutrition among children; rather it is ignorance.

The breakfastless child presents a baffling problem to school authorities who do not provide school lunches, as well as to the teacher. In innumerable cases reported from the larger cities of this country, as well as Europe, the breakfast, provided any is had, consists of such things as bread, and tea, or coffee. Often the father is dead and the mother leaves the home for her work before six o'clock, allowing the children to 'pick up' their own breakfast when they get up. In many cases the parent does not return to the home before seven o'clock at night, and then the children receive their first and only real meal of the day. The dangers in such procedure are too obvious to need discussion.

Numerous investigations into the extent of malnutrition in school children have been made within the past fifteen years. Among them may be mentioned a series of special records kept by the Medical Inspection Department of the New York City schools; an investigation conducted by the New York Committee on the Physical Welfare of School Children; a study made by the medical inspectors of the Chicago schools, and others. The general conclusion from

these and other studies made, both in this country and Europe, is that somewhere in the neighborhood of ten per cent of our elementary-school population are seriously underfed, while another ten per cent or more are suffering from less acute forms of malnutrition.

Certain significant relationships. Gastpar, previous to 1910, had demonstrated [1] in Stuttgart the direct relationship between nutrition and resistance to disease. Some 8000 children, previously grouped according to several grades of nutrition and physical defectiveness, were submitted to thorough nutritional diagnosis, and demonstrated remarkably that susceptibility to disease is in regular and direct relationship to the lowering of the standard of nutrition. Thus, those children showing the poorest nutrition revealed 79 defects out of each 100 examined, as opposed to 18 defects out of each 100 of those best nourished. Throughout the series also, the incidence of defects increased regularly with the descent of the children on the scale of comparative nutrition. In later investigations, Dr. Gastpar continued his observations somewhat extensively, but found no reason to doubt the conclusion reached earlier. It is a fact now universally recognized among child workers that defective nutrition is the direct forerunner of many diseases and defects, as well as an evidence of the presence in the child of adenoids, overgrown tonsils, etc. It is also true that the child who is suffering from malnutrition is far less able to 'throw off' incipient disease, once it has fastened itself upon him, because of his lowered resistance power.

Another important relationship is found in the correlation between the undernourished child and the retarded child. One writer states that malnutrition is from two to three times as common among children mentally retarded as

[1] "Die Beurteilung des Ernährungszustandes der Schulkinder"; in *Zeitr. f. Schulgesundtheitspflege*, 1908. Sn. 689–705.

among those pupils who are up to grade. It is a fact unescapable that a common cause back of the repeater and the backward child is cell-hunger, more or less chronic and severe. In other words, the unsatisfactory pupil is often a hungry pupil. The child who comes breakfastless to school, or who goes home at noontime to a dinnerless home, or who yet spends the pennies, given by the parents to keep him from coming home at midday, for pickles or jelly doughnuts or candy, is the child who lags behind the class and becomes the chronic repeater, often failing to finish more than the fifth or sixth grade before becoming 'of age,' from the school point of view. Of 100,000 London school children examined, it was found that 28 per cent of the dull pupils were undernourished. Macmillan and Bodine (quoted by Terman) found that of 2100 retarded pupils, 54.6 per cent were sufferers from malnutrition. The German investigators, notably Gastpar and Tonzig, have found the percentage of correlation between retardation and malnutrition to run extremely high. In fact, it may yet appear that hitherto undreamed-of things can be accomplished in the training of the defective child, if only his condition of bodily nutrition can be early brought up to standard.

The following account of the heedlessness and dullness of the undernourished child, given by Margaret McMillan, is especially good:

> The semi-starved, the underfed and ill-fed never get any real hold of the past or even of the present. They forget their parents like small children. "Where is your mother?" I asked one day of a tall girl in a train. She looked amazed for an instant, and then said in a dull voice and without feeling: "She drowned herself in the dam." That may have been an extreme case, and for that reason it may serve to show the real nature of forgetfulness in many other less striking cases. In the special drill classrooms and school camps where teachers stand for the first time before elementary school children the process of teaching is complicated at

first by the brain dullness of even well-endowed children. "Please shut the door, Emily." Emily takes no notice. "The door is open; shut it." A light glimmers in Emily's eyes. "Shut the door." At last she hears and obeys gladly. She is not deaf through the ear. She is not disobedient. She is deaf through the brain, and this kind of deafness is the result of want of food and want of stimuli. In that state of dullness millions pass their lives. They are diagnosed as naturally dull, unfit for secondary education.

There is no question but that Miss McMillan is here pointing out a fundamental truth. Who shall say that the dull child, the nervous child, the apathetic, listless, retiring child who gazes at one out of wide, expressionless eyes, often set in a face of stony impassiveness, is not primarily a child who is hungry, chronically hungry? And hungry so habitually as not to realize himself that he is hungry? Surely, if malnutrition is not the only factor in his physical and mental passivity, it is nevertheless likely to be a prominent one.

School feeding. As an effective means of improving the nutritional condition of the school population, school feeding has been proposed and developed in many localities. This movement had its inception in France, but has developed most extensively and with the greatest show of popular approval in England. In the latter country, the passage of the Education Act of 1870 enforcing school attendance, brought to the notice of society thousands of sickly and emaciated children, who were thus withdrawn from the slums of the great cities of England and made the objects of a large number of volunteer feeding societies. The testimony became universal that striking improvements in the physique, as well as in school performance, followed the initiation of feeding programs everywhere. Thirty-six years later, in 1906, an act was passed by Parliament providing all undernourished children with a school meal, which was to be sold at cost to those who could afford it, but was to be given free

to those who could not. In 1914–15, a total of some thirty million meals were served under this Act.

In most of the other countries of Europe, school feeding has been carried on for a generation, either by volunteer societies or by municipalities.

In the United States, the movement was inaugurated in New York City, in 1908, in two schools. The work grew rapidly, but was promoted entirely by voluntary societies until 1920, at which time the Board of Education assumed full responsibility for the work in all boroughs. The following is a typical menu provided by the New York authorities for the lunch-rooms under their jurisdiction:

Menus for Week of April 19–23

Monday: Cocoa, buttered roll, stewed corn, stewed prunes.

Tuesday: Cream of pea soup, peanuts and cottage cheese sandwich, brown Betty, with lemon sauce, fruit tapioca (apricots or peaches, syrup served on top).

Wednesday: Vegetable soup, baked beans, vanilla cornstarch with chocolate sauce.

Thursday: Lima bean and tomato soup, buttered roll, cream tapioca, rice pudding.

Friday: Cocoa, salmon sandwiches, sliced fruit, and oatmeal cookies.

The main dishes listed above sell for three cents. In addition to these articles the child may purchase a slice of bread for two cents, a cup of milk for three cents, crackers (one sweet and one unsweetened) for one cent, and candy (either chocolate or hard candy) for one cent. For ten cents a child is able to buy a wholesome, substantial lunch consisting of three main dishes and a sweet, either a cracker or candy.

No adequate census has ever been taken of the extent of school feeding in America, but a recent survey of the Bureau of Municipal Research (New York) gives a fair idea of the growth of the movement.[1] In February, 1918, the Bureau

[1] See Bulletin no. 37, 1921, United States Bureau of Education; *Malnutrition and School Feeding*, by John C. Gebhart.

sent a questionnaire, covering the essential points of school feeding practice, to 131 cities of 50,000 population or over; replies were received from eighty-six of them. The growth of the work in various cities during the four or five years preceding the time of the survey is clearly shown in the following table:

TABLE 13. GROWTH OF SCHOOL LUNCH SERVICE IN CERTAIN CITIES WITH 300,000 POPULATION AND OVER

(Prepared by the New York Bureau of Municipal Research)

CITY	PERIOD	GROWTH
New York (Manhattan)	1911–1915	Elementary — 9 to 49 schools
New York (Brooklyn)	1912–1915	High — 4 to 16 schools
Chicago	1912–1916	Elementary — 10 to 28 schools Intermediate High — 0 to 31 schools
Philadelphia	1913–1917	Elementary — 0 to 16 schools
St. Louis	1913–1916	Elementary — 1 to 5 schools
Boston	1911–1917	High — 18 to 18 schools
Pittsburgh	1914–1917	High — 3 to 7 schools
Los Angeles	1914–1917	Elementary — 7 to 10 schools Intermediate High — 13 to 16 schools
San Francisco	1912–1916	High — 1 to 3 schools
New Orleans	1911–1916	Elementary — 2 to 10 schools High — 3 to 3 schools
Minneapolis	1911–1916	Elementary — 2 to 6 schools High — 5 to 6 schools

Open-air schools. Another important agency designed to promote the physical welfare of undernourished and otherwise sickly children is the open-air school. This movement originated in Charlottenburg, Germany, in 1904. From Germany, schools of this type spread to England, and thence to America. In the latter country, Providence, Rhode Island, initiated the first open-air school in 1908, by removing one side of a remodeled room, and admitting "anæmic and pretubercular" children. When the first children entered in January their average hæmoglobin test was 74. In

June it had risen to 84. Boston and New York speedily followed the example of Providence, and other cities fell into line in turn, so that to-day the majority of the moderate-sized and large cities in this country maintain some form of open-air classes or open-window schools. While in the main thus far these rooms are intended exclusively for anæmic children, or for those having definite predisposition to tuberculosis, there is no good reason why progressively more and more healthy and non-anæmic children should not enjoy the advantages offered by attending schools of this sort. It is greatly to be hoped that in the not too distant future open-air rooms will be provided for many more children than those now enjoying them.

In practice at the present time, it works out that those children who are diagnosed in the periodic health examination as suffering from deficient nutrition, anæmia, etc., are assigned by the director of school health work to the open-air classes, provided, of course, such are maintained in the community. Plenty of warm extra clothing is furnished; hot lunches are served in the middle of the morning and afternoon, as well as at noontime; rest or sleep periods are arranged to follow the midday meal. Careful weight and nutrition records are kept daily or weekly, and children admitted to these classes, almost without exception, gain in weight very rapidly indeed, and can often be returned to their regular classes within the year. The size of special classes of this nature is kept as small as possible so that more time for individual instruction will be available, and the curriculum is kept as elastic as is consistent to provide for the maximum progress that can be maintained. It should be understood that these open-air classes in the schools are not for children who actually have tuberculosis in an active form, but rather for those who by virtue of poor nutrition are excellent candidates for it. For the former type of

children, special placement in sanatoria, where they are segregated from the non-tubercular and the merely anæmic children, is highly essential.

The children's diseases. These are a group of several communicable diseases which very commonly attack children, and more rarely adults. They include chicken-pox, diphtheria, measles, mumps, scarlet fever, small-pox, whooping cough, etc. To this list should be added the common colds, which are likely to prevail among both children and grown-ups at certain seasons of the year. These last are especially dangerous because of the ease with which they run into pneumonia, influenza, or other respiratory or pulmonary diseases. Infantile paralysis belongs also in the list, although the fact of its being typically a disease of infancy rather than of the school age removes it from the scope of the present chapter. Malaria and hookworm occur with considerable frequency in the southern part of the United States. The former is due to the bite of the female mosquito *Anopheles*, which first sucks the blood from some one ill with the disease and subsequently injects the germs through the skin of a well person. The latter disease is caused by small worms, found in warm countries in the soil polluted by human sewage. These penetrate through the victim's skin — usually through his bare feet — thence working their way into the intestine to which they affix themselves immovably, and where they live and fatten on the nutriment intended for the organism. Malaria may be prevented by destroying the breeding-places of mosquitoes, and cured by the drug quinine; hookworm may be prevented by properly reducing and disposing of sewage, and cured by the drug thymol.

How the diseases are ordinarily spread. To Louis Pasteur (1822–1895), the great French scientist, we owe the discovery of the fact that diseases are caused by microbes.

Lister, an English surgeon, founded modern septic surgery on the basis that if these germs could be absolutely excluded from wounds, pus could not form and healing would take place very rapidly. The history of the development of this germ theory of disease has been a most fascinating story. One after another, diseases have yielded up their secrets to the searching lens of the bacteriologist — tuberculosis, typhoid fever, diphtheria, pneumonia, and many others of the scourges of mankind. Always it is the same story: some specific germ that enters the body, most commonly through the mouth or nostril, at a time when the resistance happens to be low, and sets up its own specific disease. Not all the microbes causing specific diseases have yet been isolated, of course. There is no doubt but that most of the children's diseases, in common with other contagious maladies, are due to these micro-organisms. Toxins produced by them are carried by the blood to all parts of the body, weakening and destroying its tissues and organs.

Since it is known that germs are the immediate causes of the contagious diseases, it is important to understand how they are passed from the sick to the well. This is brought about either by direct contact with a 'carrier,' or with discharges from his body, or with clothes, towels, dishes, or other objects that he has recently handled. Drinking-water, milk, and foods are often contaminated thus by carriers of disease germs. A carrier may be either an individual who has a disease in a recognized and typical form; or one who has it in such a mild form as not to recognize it; or one who has apparently recovered from the disease, but in whose oral passages the microbes still linger; or one who, seemingly immune, yet carries in his body the living germs. From contact with any one of these four types of carriers a well person may contract the specific disease carried by him.

In the school environment where children from all kinds of homes are brought into closest proximity, it is very easy indeed for diseases to spread, especially when we reflect that the resistance power of the young is relatively low. Common towels, drinking-cups, pencils, certain types of bubblers, etc., are through intimacy of use particularly dangerous as the vehicles of disease transmission. Use of a common handkerchief by several members of a family, 'swapping' bites, putting the fingers in the mouth, nose, eyes, or ears, etc., are easy means of disseminating microbes, as are also coughing or sneezing with the nostrils uncovered. There is plenty of opportunity for the teacher to stress, in her health lessons, the importance of keeping down the spread of common colds and other diseases by abolishing these and other practices or conditions that make for their dissemination through the school population.

What should be done in a school epidemic? Some years since, closure of the school was commonly recommended in case any of the children's diseases broke out in epidemic form. Within the past decade, however, opinion and practice have changed considerably with reference to this matter. A committee appointed by the American Health Association at its annual meeting in October, 1917, to "attempt to discover what is the proper practice as to continuing or closing the schools" during epidemics [1] reported, in substance, that the closure of schools is an "extremely clumsy, unscientific, and unsatisfactory method of control, resulting in loss of school time and money, on the one hand, and, on the other, permitting infected children to mingle with others on the streets and at large, thus tending to spread rather than check the epidemic." The consensus of opinion among the committee, as a result of their study, favors the careful daily

[1] The six diseases specified were measles, whooping cough, scarlet fever, diphtheria, smallpox, and poliomyelitis.

inspection of affected schools, the isolation of sick children, and the quarantine of contacts, thus permitting the greater portion of the children to continue with their school work uninterruptedly. Exception is made in the case of diseases whose etiology is not known or whose severity defies all efforts at control, as was true of the influenza epidemic of 1918. The same report concludes that disinfection by fumigation is unnecessary and ineffective, and the use of chemical solutions is generally unnecessary. Disinfection by air and sun, and cleansing with hot water, soap, and scrubbing, are to be recommended.

Suspicious general symptoms. While it is not intended that teachers shall be also physicians, it is highly important, in the interest of efficiency in the health service of the school, that they be clever at recognizing certain suspicious symptoms of contagious diseases ordinarily manifested by children about to contract them. In some respects the teacher can detect trouble more favorably than the nurse; the former is omnipresent with her children, while the latter is necessarily only occasionally with them; the teacher knows her children and is quick to detect modifications in their general appearance; the nurse can only note these by actually searching for them. In general we may say that the symptoms enumerated in the following list should be among those looked upon with extreme suspicion by the teacher:

Running eyes	Headache
Catarrhal cold	Eruption or rash
Persistent cough	Languor
Sore throat	Vomiting
Fever	Sudden feeling of illness.

Whenever any of these are manifested by a child, the teacher should forthwith remove him from the room and call the nurse or physician. It is better to err on the side of caution than to be negligent in this matter; better to make a

mistake occasionally than to jeopardize the health of all the children in the room by leaving an ill child in their midst for a day, or even for an hour. Teachers cannot be too cautious in thus protecting the health of their rooms.

Some common communicable diseases among children. Table 14 (pages 392, 393), adapted from a bulletin of the New York State Department of Health, enumerates the principal symptoms of, the methods of infection by, and certain after effects from, the chief children's diseases.

In Table 15 (pages 394, 395) are presented the rules of procedure with reference to isolation and exclusion from school, as laid down by the New York State Department of Health.

Preventive measures against smallpox, typhoid fever, and diphtheria. We have referred in a previous chapter (see p. 221) to the importance of vaccination against smallpox. This disease, together with two other very serious ones, typhoid fever and diphtheria, could be stamped out without any question if universal vaccination were practiced. As it is, these diseases are no longer great scourges that attack whole cities, but occur only in sporadic cases here and there throughout that part of the world where preventive measures are taken against them. There are always a sufficient number of persons in the general population, however, who have not been immunized to fall prey to these diseases and pass them on in turn to others susceptible to them.

Vaccination against smallpox. The following information concerning smallpox vaccination [1] should be disseminated among teachers and parents everywhere in the interest of further banishing this wretched disease from the ranks of men:

> Compulsory vaccination against smallpox is necessary; it is safe; it is an individual boon and a public duty; and it is the one sure means of protection against this dreaded disease.

[1] From *The Boston Medical and Surgical Journal*, May 1, 1924.

1. *What is vaccination?* Vaccination is the introduction into the skin of the virus of vaccinia or cowpox, causing a local eruption and benign constitutional reaction which result in protection against smallpox.

2. *Vaccination is necessary.* Virulent smallpox is always endemic in Asiatic countries, and also in various countries of Europe. This country is exposed to the introduction of this disease through our ports, because the incubation period of the disease is in many cases longer than the duration of the sea voyage. Virulent smallpox has been introduced into this country on several occasions in this way. Smallpox is endemic in the United States, and while the majority of cases are of a mild type with a low fatality, the virulence of the disease has increased several fold in the past five years, and there have been outbreaks of a virulent form of the disease in several states.

3. *Vaccination is safe.* Since 1902 all vaccine virus produced in the country is subjected to the rigid regulations promulgated by the Hygienic Laboratory of the United States Public Health Service. All steps in the process of manufacture and of testing of this product are specified by the Hygienic Laboratory. All manufacturing establishments are subject to inspection by the Federal authorities, and from time to time these authorities examine the products of all the laboratories for harmlessness and potency. Vaccine virus as it is produced to-day contains the virus of vaccinia or cowpox propagated on the skin of healthy calves and is a highly refined and harmless prophylactic agent. If vaccination is properly performed and the vaccination site is properly cared for, the danger attending its use is negligible.

4. *Vaccination is a public duty.* Experiences all over the world show that vaccinations properly made and resulting in successful "takes" give a high degree of individual protection against smallpox. One successful vaccination gives, as a rule, complete protection for a period of five to seven years, while two successful "takes" usually confer a lifelong immunity to this disease. A person vaccinated once and at a later time contracting smallpox, as a rule contracts the disease in a less serious form (varioloid) than unvaccinated persons. A review of the statistics of all countries, and particularly of the various States in the United States of America, shows that the number of smallpox cases is in direct proportion to the number of unvaccinated persons. Therefore, it becomes a public duty of every person to be vaccinated.

Table 14. Symptoms and Causes of Certain of the Children's Diseases

Disease	Principal Signs and Symptoms	Method of Infection	Remarks
Chickenpox	Sometimes begins with feverishness but is usually very mild and without sign of fever. Rash appears on second day as small pimples, which in about a day become filled with clear fluid. This fluid then becomes matter, and later the spot dries up and the crust falls off. May have successive crops of rash until tenth day.	Mouth spray and crust of spots.	When children return, examine head for spots. All spots should have disappeared before child returns. A mild disease and seldom any after-effects.
Diphtheria	Onset insidious, may be rapid or gradual. Typically sore throat, great weakness, and swelling of lymph nodes in the neck, about the angle of the jaw. The back of the throat, tonsils, or palate may show patches like pieces of grayish-white kid. The most pronounced symptoms are great debility and lassitude, and there may be little else noticeable. There may be hardly any symptoms at all. Cases of croup are frequently in reality laryngeal diphtheria.	Mouth spray and discharges from nose, mouth, and ears. Milk may convey infection.	Very dangerous, both during attack and from after-effects. When diphtheria occurs in a school, all children suffering from sore throat should be excluded. There is great variation of type, and mild cases are often not recognized, but are as infectious as severe cases. Outbreaks due to milk infections are not uncommon.
Measles	Begins like cold in the head, with feverishness, running nose, inflamed and watery eyes, and sneezing; small crescentic groups of mulberry-tinted spots appear about the third day; rash first seen on forehead and face. The rash varies with heat; may almost disappear if the air is cold, and come out again with warmth.	Mouth spray and discharges from nose and mouth.	After-effects often severe. Period of greatest risk of infection first three or four days, before the rash appears. Great variation in type of disease. Dangerous in children under 2 years of age.
Measles German	Illness usually slight. Onset sudden. Lymph nodes back of ears enlarged. Rash often first thing noticed; no cold in head. Usually feverishness and sore throat and the eyes may be inflamed. Rash something between measles and scarlet fever, variable.	Mouth spray and discharges from nose and mouth.	After-effects slight. Regulations strict, because frequently confused with scarlet fever.
Mumps	Onset may be sudden, beginning with sickness and fever, and pain about the angle of the jaw. The glands become swollen and tender and the jaws stiff, and the saliva sticky.	Mouth spray and discharges from nose and mouth.	Seldom leaves after-effects. Very infectious. Occasional inflammation of genital organs — male and female.

Table 14. Symptoms and Causes of Certain of the Children's Diseases (*continued*)

Disease	Principal Signs and Symptoms	Method of Infection	Remarks
Scarlet Fever	The onset is usually sudden, with headache, languor, feverishness, sore throat, and often vomiting. Usually within twenty-four hours the rash appears, finely spotted, evenly diffused, and bright red. The rash is seen first on the neck and upper part of chest, and lasts three to ten days, when it fades and the skin peels in scales, flakes, or even large pieces. The tongue becomes whitish, with bright red spots. The eyes are not watery or congested.	Mouth spray, discharges from nose and mouth, discharges from suppurating glands or ears. Milk specially apt to convey infection.	Dangerous both during attack and from after-effects. Great variation in type of disease. Slight attacks as infectious as severe ones. Many mild cases not diagnosed and many concealed. The peeling may last six to eight weeks. A second attack is rare. When scarlet fever occurs in a school, all cases of sore throat should be sent home. More fatal in children under ten years.
Smallpox	The illness is usually well marked and the onset rather sudden, with feverishness, severe backache, and sickness. About third day a red rash of spotlike pimples, felt below the skin, and seen first about the face and wrists; spots develop in two days, then form little blisters, and after two days more become yellowish and filled with matter. Scabs then form which fall off about the fourteenth day.	Mouth spray, all discharges, and particles of skin or scabs.	Peculiarly infectious. When smallpox occurs in connection with a school or with any of the children's homes, an endeavor should be made to have all persons vaccinated. Cases of modified smallpox in vaccinated persons may be, and often are, so slight as to escape detection. Fact of existence of disease may be concealed. Mild or modified smallpox as infectious as severe type.
Sore Throat Acute septic	Begins with sore throat and weakness. Throat diffusely reddened and may show patches like diphtheria.	Mouth spray and discharges from nose and mouth. Milk often conveys infection.	Often leads to serious results, affections of heart, kidneys, etc. Very apt to cause epidemics if milk or other raw foods are contaminated.
Whooping Cough	Begins like cold in the head, with bronchitis and sore throat, and a cough which is worse at night. Symptoms may at first be very mild. Characteristic 'whooping' cough develops in about a fortnight, and the spasm of coughing often ends with vomiting.	Mouth spray and discharges from nose and mouth.	After-effects often very severe and disease causes great debility. Relapses are apt to occur. Second attack rare. Specially infectious for first week or two. If a child vomits after a paroxysm of coughing, it is most probably suffering from whooping cough. Great variation in type of disease. Often fatal in young children.

Table 15. Rules for Isolation and Exclusion from School

New York State Department of Health

Disease	Exclusion from School					Duration of Exclusion from Date of Onset				
	Patient	Other children of same household		Other school-children especially exposed		Patient	Patient goes to hospital		Patient remains isolated at home	Children exposed at school
		Non-immunes	Immunes[1]	Non-immunes	Immunes[1]		Other children of the same household	Other children who remain at home	Children who leave household as soon as disease is discovered	
Chickenpox	Yes.	Yes.	No.	Yes.	No.	Until all scales are shed and after disinfection of person: at least 12 days.	Exclude until 22d day after child last saw patient.			Exclude from school during 11th to 22d day after child last saw patient.
Diphtheria	Yes.	Yes.	Yes.	Yes.	Yes.	Until patient is recovered and has two successive cultures from throat and nose which contain no diphtheria bacilli. Disinfection of person.	Until two cultures, 24 hours apart, from nose and throat are reported negative. Those showing diphtheria bacilli should be immunized.	Until quarantine has been raised and two successive negative cultures subsequently obtained.	Until two cultures, 24 hours apart from nose and throat are reported negative. Those showing diphtheria bacilli should be immunized.	
Measles	Yes.	Yes.	No.	Yes.	No.	Until recovery and disinfection of person; at least 10 days from onset.	Exclude until 15th day after child last saw patient.			Exclude from school during 8th to 15th day after child last saw patient.

[1] Immunes are those who have had the disease. It is assumed that the patient is strictly isolated.

Disease	Exclusion from School					Duration of Exclusion from Date of Onset				
Measles German	Yes.	Yes.	No.	Yes.	No.	Until recovery and disinfection of person; at least 8 days.	Exclude until 22d day after child last saw patient.			Exclude from school during 11th to 22d day after child last saw patient.
Mumps	Yes.	Yes.	No.	Yes.	No.	Two weeks, and until after disinfection of person.	Exclude 15th to 22d day after child last saw patient.			Exclude from 15th to 22d day after child last saw patient.
Scarlet Fever	Yes.	Yes.	Yes.	Yes.	Yes.	At least 30 days and until discharges have ceased and disinfection of person.	Seven days from time child last saw patient.	Until seven days after quarantine has been raised.	Seven days from time child last saw patient.	
Smallpox	Yes.	Yes.	Yes.	Yes.	No.	Recovery and disinfection of person.	Exclude until 22d day after child last saw patient or 7 days after successful vaccination and disinfection of person.	Exclude until 22 days after quarantine has been raised or 7 days after successful vaccination and disinfection of person.	Exclude until 22d day after child last saw patient or 7 days after successful vaccination and disinfection of person.	Exclude 22 days or 7 days after successful vaccination, unless they have been successfully vaccinated within 1 year, in which case they may return at once.
Sore Throat Acute septic	Yes.	No.	No.	No.	No.	Until recovery.				
Whooping Cough	Yes.	Yes.	No.	Yes.	No.	Eight wks or until 1 wk. after last characteristic cough and disinfection of person	Fourteen days, provided no cough develops meantime.			

That the laws requiring the vaccination of all children as a requisite for school attendance violate no constitutional rights of the individual, is a decision of the highest courts of this country.

5. *Universal vaccination is the most successful means available for preventing smallpox.* The claim that general sanitation and that isolation of smallpox patients are sufficient to control smallpox is fallacious. Smallpox appears in some of the most sanitary communities and among people of strict hygienic habits; on the other hand smallpox can be controlled by vaccination even in the most insanitary districts. Isolation while desirable and helpful cannot alone control smallpox, because many cases are not detected and isolated until they have had an opportunity to spread the disease to others.

A study of the smallpox situation in this country and a review of the laws relating to vaccination and their enforcement in the various States show conclusively that the best vaccinated States have the least smallpox. Massachusetts with its compulsory laws and with its free distribution of vaccine virus enjoys an almost complete freedom from this scourge. Other States in which there are no compulsory vaccination laws, or in which such laws are not enforced or have been repealed, have smallpox as an endemic disease, with cases running at times into the thousands.

Because of the long-continued freedom from this disease, and of the mildness of the majority of cases, many people feel that smallpox no longer possesses its old-time menace, and they, therefore, have become indifferent to the value of vaccination. Hence, it is all the more important that every effort be made to maintain the present vaccination laws on the statute books, and to encourage the people to be vaccinated. Any relaxation of enforcement and any steps which would result in a larger proportion of unvaccinated persons in our communities, would inevitably invite the invasion of and spread within our communities of this great pestilential scourge.

Vaccination against typhoid fever. One of the most important causes of mortality and disability in both the Federal and the Confederate Armies during the Civil War was typhoid fever; in the Spanish-American War the toll of suffering and death taken by this disease was relatively greater still; in fact, when peace with Spain was concluded it is not an exaggeration to state that virtually our entire

army was *hors de combat* by reason of typhoid fever, and this notwithstanding the fact that the means of the spread and contraction of the disease was as well known as it is to-day.

It was largely the experimental work carried on by the army health officials during the Boer War that final success was achieved in protective vaccination against typhoid, and for the first time in the history of warfare, due to the knowledge thus acquired, typhoid fever in the World War became a negligible factor so far as the allied armies were concerned. Such protective immunity was the result of the compulsory vaccination of every soldier against typhoid fever.

Typhoid vaccination consists in injecting subcutaneously typhoid organisms that have been cultivated artificially in the laboratory, and then killed with heat and mixed with some preservative, such, for example, as creosol. No live microbes are therefore introduced into the blood of the individual, as is sometimes understood. The stimulus provided by these dead organisms is sufficient to cause the blood within a few weeks to build up an immunity to infection from the virulent germs of typhoid fever. Since experience has demonstrated the amount of the substance necessary to produce immunity, and with refinement in the methods of its preparation, sickness or serious local reactions from the injections are no longer known. It is rare indeed that anti-typhoid vaccination will necessitate any interruption of the person's daily routine of work. It is customary to make three injections, during the course of about two weeks, the number of dead organisms being increased with each injection, and the largest amount of fluid being introduced at any time being about fifteen drops.

Children and grown-ups are about equally susceptible to typhoid fever. It is spread through polluted drinking-water; milk contaminated by 'carriers' may also be an important vehicle of its communication. Flies are known to

be common carriers of the bacilli. Great importance therefore attaches to the purification of the water supply; to regular inspection of all producers, distributers, and containers of milk; and to the anti-fly campaigns conducted in most homes and in some municipalities every season.

Diphtheria and the Schick Test. Diphtheria has long been one of the most virulent of the diseases of early childhood, taking an annual toll of 15,000 lives in the United States. For some years we have had an antitoxin which, when given to those who are exposed to, or manifest early symptoms of the disease, destroys the toxins and saves the cells of the organism from poisoning while the natural defenses of the body are mustering to kill out the germs. The antitoxin used for this purpose is derived from the blood of the horse, in much the same way that that for smallpox is taken from the blood of healthy calves. The procedure is an interesting one. The toxin produced by colonies of diphtheria germs growing in beef broth is injected into the animal's blood, which forthwith begins to work up an antitoxin. The initial dose is followed at intervals by increasingly large doses, so that the horse is stimulated to develop the strongest possible antitoxin. Some of the blood is then withdrawn from the animal's veins; this is allowed to clot, and the thin yellow serum which appears around the clot contains the antitoxin. This serum is freed from certain impurities and supplied to physicians as diphtheria antitoxin.

The *Schick Test,* evolved recently, represents one of the longest steps forward in the scientific prevention of disease that has been made in a generation. Recourse to the antitoxin injection, while it succeeded in making recovery possible in the case of large numbers of sufferers from diphtheria, and in providing a fleeting immunity in those exposed to it, was of no value as a universal and permanent preventive. It remained for the Schick test to place diphtheria preven-

tion within easy reach of everybody. In this test a small amount of diphtheria toxin is injected into the skin of the arm with a fine syringe needle. A few hours later a small reddish tinge develops around the point where the needle was inserted, in the case of an individual who is susceptible to diphtheria. If no red spot appears, it is an indication that the individual reacting thus negatively already has in his blood substances which render him immune to the disease, and he need have no fear of contracting it. A high ratio of children under six years react positively to the Schick test, and hence are in need of immunization. In the school population some fifty per cent of the children are ordinarily found susceptible. For those not immune the 'T.A.' (toxin-antitoxin) treatment is necessary to render them so. To a person at the time in good health, but susceptible to diphtheria, this treatment gives lasting immunity after a period of some three months, during which the body is manufacturing its natural defense substances.

The treatment consists merely of injecting toxin-antitoxin, a mixture of the poisons produced by diphtheria germs and the antitoxin, into the skin. To make triply sure, the inoculation is performed ordinarily three times. Six months after, a final Schick test is made to determine definitely that immunization has been accomplished. A few individuals will still be found susceptible, and need further inoculation. In neither the test nor the immunizing treatment are any germs introduced into the body, so that there is no possibility of contracting diphtheria from this process. Every child should be given the test, and those found susceptible should be inoculated. In this simple way a dread disease can be literally wiped out of civilized lands.

Skin diseases. Under this caption brief reference should be made to four infections: (1) *pediculosis;* (2) *ringworm;* (3) *scabies;* and (4) *impetigo.* The first of these, pediculosis,

commonly called 'head lice,' is a condition as contagious as it is common among school children, and causes them much discomfort and annoyance. The eggs or nits are easily recognizable on the strands of the child's hair. Thorough washing of the scalp with soap and water, followed by saturating the hair with kerosene or larkspur tincture, and then wrapping a towel about the scalp for a night, will destroy the lice. In the morning, another washing with soap and water and combing with a fine-tooth comb wet with vinegar will leave the scalp and hair clean of all nits. At some time or other during their school life, children become infected but there is no excuse for the condition persisting longer than twenty-four hours.

Ringworm is perhaps the most serious of the common skin diseases of childhood. Occurring mainly on the face and scalp, it is often hard to cure, and not infrequently all but ruins large areas of the hair, leaving permanently bald spots as large as two inches in diameter. It spreads in a typically ring-shaped form, whence its name. Ring-worm is not a protozoan disease, however, nor is it caused by a 'worm.' Its cause is a fungus or plant parasite which grows in the skin and hair. Frequent cleansing and treatment with iodine or zinc ointment are efficacious in the milder cases, but more insidious infections yield very slowly to any treatment.

Scabies, more popularly known as 'itch,' while less common than the other skin affections, is equally uncomfortable. It is caused by a small mite — the 'itch mite,' that burrows into the skin and deposits its eggs, which hatch and develop others. Scabies commonly appears along the margin of the hair, on the neck, in the armpits, and on folds of flesh between fingers or toes. It frequently spreads over a considerable area, being scratched in progressively by the afflicted victim. Cleansing and application of sulphur ointment ordinarily bring about rapid recovery.

Impetigo is a fairly prevalent skin disease among children, being usually confined to the face, and sometimes the hands and fingers. It is readily recognized by small risings of the skin over the area infected, with the gathering of fluid underneath. This fluid, when released by scratching, spreads the infection to the parts it touches; the wounds heal over with thick, hard crusts, which have to be soaked off by the application of sweet oil in order that the infected area underneath may be cleansed and treated with sulphur or zinc ointment.

Some wise habits to cultivate in the avoidance of diseases. In the interest of avoiding contagious diseases, certain general rules may be laid down for strict observance. Teachers should not only themselves practice them scrupulously, but should build a respect for them into the very structure of their children:

1. Keep away from those diseased.
2. Develop a 'ventilation consciousness.'
3. Exercise strict habits of personal cleanliness.
4. Get plenty of good, refreshing sleep, regularly.
5. Take plenty of exercise in the out-of-doors.
6. Avoid overeating, and maintain a vigorous digestion.
7. Guard the mouth from entry of germs and dust.
8. Take care of any incipient cold.
9. Keep the body warm, dry, and comfortable.
10. When ill, spare others.
11. Respect, embrace, and disseminate the conservative findings of the laboratory with reference to prevention of disease.
12. In fine, do nothing to lower and everything possible to raise the resistance power of the body.

TEACHING POINTS IN THIS LESSON

1. The importance of healthy childhood.
2. The need for parental and social coöperation with the work which the health agencies of the community are fostering.
3. The seriousness of all disease, of whatever character.
4. Avoidance of disease rather than willful exposure to it.
5. The value of the health examination, both at school entrance and periodically thereafter.

6. Common diseases and common-sense care of the teeth.
7. Tonsils and adenoids and their relation to our health.
8. The significance of proper nutrition of the body.
9. School feeding and open-air schools for the unwell.
10. The germ theory of disease.
11. How diseases are spread.
12. Avoidance and control of epidemics.
13. Disease symptoms every one should recognize.
14. The prevention of disease through immunization.
15. The Schick Test.
16. Some wise rules of health for us all.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Secure the latest report of mortality statistics, and study the types of vital diseases and the age of their incidence. Compare the local infant, pre-school, and school-child mortality with the statistics of the State at large, or with those from other communities.
2. Report any cases you may know in which parents have, through ignorance, superstition, or other factor, rendered of no effect, or impeded, the efforts of the school health workers.
3. Make a survey of the condition of the teeth of the children in some grade or room of the practice school, using the health record cards as the basis for your study.
4. Draw up a lesson on some phase of dental hygiene which you would teach to primary children; to intermediates.
5. Make a study of the school lunches served in any school or schools with which you may be familiar. Consult the teacher with the purpose of determining her reactions to the results being achieved.
6. Report briefly on the experimental work of Jenner, Pasteur, Metchnikoff, Lister, Behring, Virchow, Koch, Schick, and Banting. Your instructor will suggest sources, and perhaps also other names to look up.
7. Make a study of one or more of the great epidemic plagues of history, reporting in writing to the class.

SELECTED REFERENCES

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3. Hoag, E., B. and Terman, L. M. *Health Work in the Schools*, chaps. 9 and 10.
4. Terman, L. M. *The Hygiene of the School Child*, chaps. 8, 11, and 12.

CHAPTER XIII

SCHOOL HYGIENE AND SANITATION

Hygienic school environment a factor in child health. "There are only two classes of buildings," says the Wisconsin Industrial Commission, "where attendance is compulsory — schools and jails." This observation is not, of course, meant to indicate that these two types of public buildings are or ought to be in any wise similar. A thoughtful expedition through the highways and byways of many of our villages, towns, and even cities, however, will reveal to the inquirer many a schoolhouse that savors strongly of another generation. Homely, forbidding exteriors; cramped, inadequate grounds upon which adjacent structures encroach; dark, dingy interiors, with rooms poorly lighted and ventilated — such buildings as these exist still in altogether too great numbers in our communities; and this notwithstanding the other and more pleasing fact that the better schools of America are housed in the most imposing buildings to be found anywhere in the world. But schools of this latter sort are by no means yet in the majority; when a community builds one of them it is pointed out and remarked upon with great local pride as "our new school plant." We felicitate ourselves little over the architecture and imposingness of our city halls and our railway stations and our business blocks, but rather take them as a matter of course. A school building constructed on a similar scale of architectural pretentiousness, however, is not passed over — or by — so lightly. "It cost us a quarter of a million dollars!" or, "A cool million in it!" are quite staggering statements when they refer to a public school plant; yet who ever heard such pecuniarily awesome reference to other edifices, such as

business blocks, office buildings, theaters, depots, etc., that cost much more?

There is encouraging evidence that municipalities are coming more and more to manifest that civic pride in the physical plants in which they house their school children that they have long evidenced in other imposing structures which their community presents. It is not an uncommon thing to find the attractiveness and equipment of the schools of a city capitalized to the fullest extent by chambers of commerce, real estate promoters, and others in their advertising campaigns to induce families to migrate from other localities. The idea of schools beautiful to look upon and to pass by is beginning to capture the fancy of the taxpayer, and he is not inclined to protest as strenuously as he once did at public expenditure for schoolhouses.

The school building program as it develops in any community, however, should be based soundly upon the recommendations of the leading architects and designers, as well as those of the practical school hygienist and sanitarian. With the old buildings, little can be done, although many of them can be remodeled with satisfactory results; but whenever and wherever a new school plant is to be erected, good judgment and foresight as well as expert advice should be vouchsafed in order to insure that in location, in spaciousness of grounds, in architectural features, and in equipment it may represent the very best achievable. Simplicity, stability, and adaptability are essential in the modern school plant that is expected to continue to be well suited to the needs of seven or eight or more generations of school children. Constructed thus wisely, there seems to be no good reason why a school plant should not do satisfactory service for well over half a century.

A hygienic and beautiful school plant needed. There are two vital reasons for making the school plant hygienic and

beautiful. In the first place, the children of the neighborhood spend in its environs the major portion of their waking hours, and it is of no slight importance that this environment be as healthful as the art and skill of man can produce. It should not be forgotten that in the great American public school, which has no exact prototype anywhere else in the world, every child of school age from every home in the neighborhood is in attendance. There are those from careful and from careless homes; those well and those unwell; those well fed and those poorly fed; those free from disease and those carriers of it. In an unhygienic school environment, the hazards to health are, for these reasons, great, and it is to the interest of all concerned that the school be constructed and maintained in accordance with the most hygienic standards.

The other reason for the healthful and the beautiful school is to be sought in the possibilities which such an institution offers for the training of the children themselves. For many of them the school is the only beautiful place in their experience; for many of them grass and flowers and shrubs grow only on the school premises; for many, the fresh air and the cheerful rooms have no counterpart at home; many of them will imbibe whatever ideas of beauty and restfulness and harmony they ever receive largely if not exclusively from the school which they attend. When one pauses to consider thoughtfully this circumstance, he is doubly impressed with the need for healthful, attractive, and even beautiful surroundings in connection with the public schools everywhere.

In the following pages an attempt will be made to summarize the modern developments of school hygiene and sanitation as they affect the location, construction, and equipment of the school plant. Teachers who are cognizant of these principles should recognize the fact that they are serving society well if they are at all times competent and willing

to advise the local authorities, when their judgment is sought, in the matter of remodeling an old or locating and equipping a new school plant.

The school site. How vividly the author recalls the location of the rural school in which he taught his first two years! A building well over a hundred years old, it had been placed by the public opinion of its day and generation on a tiny shelf that jutted from the side of a hill, and ascent to which was made by climbing a winding footpath some forty feet sheer upward from the road below. The only frontage was thus comprised of a bank rising at an angle of some 45° from the highway to the doorstep. A heavy stone wall enclosed the entire hill, drawing back sufficiently at the shelf to permit the schoolhouse to stand in the unenclosed area, with a narrow pass perhaps thirty inches wide between building and investing wall. At one point this flume broadened out about eight feet to permit the inclusion within it of a small partitioned outbuilding, used as a toilet. Two imposing signs challengingly topped the wall at either corner of the schoolhouse, bearing the forbidding legend: "No Trespassing On These Premises." What though the 'premises' were but a pasture for cows? And what though the only pasturage provided for the children to frolic and gambol in was a dirt bank twenty-five feet wide by forty feet slant? Truly there was open land — land everywhere — but not a square foot to play upon, save in the roadway or surreptitiously behind the wall in the pasture. Had the founders of the school sought high and low throughout the township, they could hardly have found a less accessible spot for the school, or one more cramped and unattractive.

Yet what of your modern city school? Is it after all so much better from the standpoint of spaciousness of location? In the rapid development of the great centers of population, vacant lot after vacant lot around the school has been

occupied until that structure, all but forgotten, has been penned helplessly in its limited quadrangle. City planning and foresight as to the future needs of the community represent strictly modern applications of government, and the school has been one of the most obvious institutions left to shift for itself. The result has been narrowing and ever narrowing yards and playgrounds, wholly inadequate for the modern physical education program being advocated so ardently by schoolmen; increasing neglect of the factor of beauty in the arrangement and care of the grounds; and the necessity of a diminishing instead of an increasing emphasis upon that element in the educative process which should go on out of doors. There is none to blame for this unfortunate and unforeseen development; and with the growth of community playgrounds and parks physically not connected with the school, such amends as possible are being made. As cities push out into the suburbs, however, and as new sections open up, let it be the first concern of those who plan for the future to set aside and hold inviolable against all coveters and assailants suitable and sufficient space for the school of to-morrow, which is to be a school almost if not quite as much outside as inside of walls.

Factors in determining the site. The following are the chief factors that need to be taken into consideration in determining the site of the school plant: accessibility, drainage, quiet, safety, and spaciousness. In the matter of accessibility, it is important that the school be located at a convenient distance for the children who are to attend it. A mile, or possibly a mile and a half, should represent the maximum distance a child should be required to walk to school. Where the school reaches out further than this for its patronage, conveyance should be provided. Proper drainage is essential in the interest of keeping dampness and moisture away from the site. For this purpose, a slight elevation, with

sandy or otherwise porous soil, is needed. Swampy ground is to be avoided. Every teacher and every pupil knows that a trolley car grinding past under the windows, the hubbub of heavy passing traffic, and the noise of adjacent shops or factories, are difficult factors to disregard in the schoolroom. Reasonable quiet and freedom from near-by commotion are indispensable to good work and perseverance of effort. Physical and moral safety are likewise factors to be considered in choosing the site for a school. The vicinity about a school should be from all viewpoints the safest place in the whole environment, next to one's home itself. Railroad crossings, speeding traffic, dangerous industries, nuisances, or places of questionable morality, have no place in proximity to a school property.

Says a recent bulletin of the United States Bureau of Education:[1]

> In places like New York City, where ground is often worth a million dollars or more per acre and the site on which a building is erected may cost more than the building, it is not to be expected that a large space can be secured for a playground. In New York this situation is met in the newer buildings by a fairly light playground which occupies the entire space of the first floor of the building and by putting a second playground on the roof, so that the school has a playground area equal to twice the site on which it is built, and, in addition, such small exterior courts as are necessary to give the building the proper light and protection from the sounds and smells of the neighborhood. Such provision should be insisted upon for new schools where adequate space cannot be secured.
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> Many of our schools have been built without playgrounds, and the sensible thing in many cases is to abandon these old sites and select new and more adequate ones, for in these old buildings without playgrounds there are practically no gymnasiums, auditoriums, or shops; no rooms for domestic economy, manual training, art, or music, or any of the other things which constitute a modern school.

The survey committee of Delaware, of which Dr. George D.

[1] Bulletin no. 45, 1921.

Strayer, of Columbia, was chairman, scoring the school buildings of Delaware outside of Wilmington, found that only four per cent or five per cent scored above 500 on 1000, and recommended that all of these buildings should be abandoned. Probably the great majority of buildings that have been constructed without playgrounds in the United States would score less than 500 points on 1000 on the scale adopted by the survey committee.

Most of these sites are in sections where land value is high, and may often be sold for enough to acquire a fine site farther out. Where this cannot be done, the school board should follow a policy of enlarging its school grounds by the purchase of adjacent grounds or buildings, whenever these can be secured at a reasonable price. The city of Houston, Texas, a few years ago issued bonds for $500,000 to enlarge the grounds of its old schools. Berkeley and Oakland, California, have also done this on a large scale.

Often it is possible to buy land on the interior of the block by cutting off 50 to 100 feet from the back ends of the house lots. In Salt Lake City, where the blocks are very large, many of the schools are thus securing playgrounds nearly three acres in size.

It is not absolutely necessary that the playground should be in the same block with the school. There are many cases where, though it is impossible to get more land in the same block without paying a prohibitive price, it may be possible to get ground across the way more cheaply. Ground of this sort may be quite as well adapted to tennis, volley ball, basket-ball, and baseball as is the school ground. In fact, it may be an advantage to have these games away from the school building and the smaller children.

To quote from a recent bulletin of the United States Chamber of Commerce:

School location in many cases is a matter of chance or of "pull." From the purely monetary side alone the cost of our schools is too great to permit us to waste a large part of it upon maintaining plants which must in great measure fail of their purpose. But beyond the present monetary loss is the far more important loss of wasted opportunity as represented in the lives of the children attending such schools.

Some of our leading cities, of course, recognize this and not only are as careful in selecting the site of a school as the business man would be in selecting that of his home or his work place; not only

are healthfulness and proper environment considered, but plans are made long beforehand, based upon studies in trend of population, so that the new school building will be where it is most accessible to its pupils. Such planning for the future also insures adequate space about the building for playgrounds.

Were the school sites in your city chosen for the convenience and safety of the children and with an eye to the probable future trend of population, or was a piece of cheap land or the desire to make the school building a "show" place the deciding factor? Public welfare demands that we use foresight in locating our school buildings, that we take into account walking distances, railroad crossings, uses of adjacent property and all the other factors that enter in.

Estimates as to the amount of space desirable for school grounds vary somewhat among schoolmen and physical educationists. Fifty square feet per child should represent the irreducible minimum for all new building programs. This minimum will not, however, permit running games or other active sports. From one hundred and twenty to one hundred and fifty square feet per pupil will be necessary for a satisfactory school ground. Two acres for a school of seven hundred pupils is not excessive. If the school is opposite or very near to a public playground or park in which play is permitted, these figures may be reduced to the minimum of fifty square feet per child.

"Children are not only entitled to be assured adequate floor space, air space, light, heat, and pure air," says a bulletin of the University of the State of New York, "but also to be surrounded by all those influences and agencies essential to the development of healthy, vigorous bodies, refined, cultivated minds, good habits, and pure morals." We must not forget of course that fine morals and preachments never succeed in getting us far in any reform. It is only when men and women actually embrace a philosophy and become new centers for its propagation that the whole social mass is on

the way to become leavened by it. So in this matter of securing better and more spacious school sites: they can and will be had when everybody is persuaded that they are necessary, even indispensable, for the highest good of the rising generation.

The building itself. The Advisory Committee on Health Education of the National Child Health Council finds the 'I,' 'L,' 'T,' or 'H' shape of building to be preferable to the solid square type, since the former can be more adequately lighted, better ventilated, and are safer. The same authority recommends that school buildings should never open directly on a street, and that there ought to be one entrance for approximately every three hundred children.

So far as possible, school buildings of more than one story should be fireproof structures. The fire hazard from wooden buildings is a serious one, and must be reduced to the lowest possible terms. Lumber is becoming increasingly scarce and expensive, and while the cost of fire-resistive construction is considerably greater still than wood construction, it is likely to prove an economy in the end, since not only is the fire hazard minimized, but the cost of maintenance and repair is distinctly less. Where finances will not permit of fireproof school buildings, corridors and stairways at least may be so protected for only a small additional outlay.

Corridors, when properly and adequately lighted as they ought to be from the outside, serve as excellent exhibition halls for the school's art gallery, and may be decorated attractively at a small cost. The Schoolhouse Department of the City of Boston requires that corridors be not less than eight feet in width, with four rooms on a floor, and not less than ten feet with more than four rooms. Authorities often recommend a minimum width of twelve feet for all main corridors.

Stairways are ordinarily between four and five feet in width, and are provided at the rate of one for every 120 to 140 pupils. It is essential that they lead directly to the outer exit; it is important also that they be well lighted, be enclosed in fire-resistive material, and be provided with landings the width of the stairs half-way between the floors. When stairs are used by small children also, a second hand-rail, lower than the first, should be provided. Cupboards or closets, frequently employed for storage underneath stair-ways, should be eliminated in the interest of safety from fire. Fire-escapes become unnecessary in buildings well planned as to stairways and exits.

In height, the building should be preferably not more than two stories, and without basement. Earlier schools were equipped with basements for two purposes: to house the heating plant, and to provide rooms for toilets. Modern schoolmen look askance on both these arrangements. In the interest of safety from fire, the heating apparatus, save in very small buildings, must be located outside the main walls of the structure; and in the interest of good sanitation as well as morality, toilets should never be placed in basements.

With reference to toilets, the National Child Health Council has the following to say: [1]

> The toilets for boys and girls should be entirely separate and the entrances as far removed from each other as possible. It is very desirable that, both in elementary and in high schools, sufficient toilet and lavatory facilities should be provided for all pupils on each floor, and that careful supervision should be given to toilets. Toilets should never be placed in basements.
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> Toilet and washroom facilities should also be provided for teachers on each floor, and special toilet and lavatory facilities should be made available for special classes. In elementary grades it is well to have a washstand with hot and cold running water in each room where possible.

[1] In *Health for School Children.* School Health Studies no. 1, United States Bureau of Education, 1923.

Wherever the toilets are placed, they must be designed so that they may be flooded with sunlight for at least a portion of the day. Separate ventilating systems should be provided for toilet rooms. Windows should be of wired glass or frosted glass; walls white or very light and glazed, so as to permit frequent washing. Floors should have a cement foundation, with a layer of asphaltum over the cement, should slant and be properly drained, so that they may be easily flushed daily.

Lavatories must be placed near all toilets, one wash basin being provided for every fifteen or twenty children. Hot water, liquid or powdered soap, and paper towels must be provided in ample quantities, and children must be trained to wash their hands when leaving the toilet room.

The classroom. It is in the classroom, as Dr. Dresslar suggests,[1] that the main work of the school is done, and it is therefore of no little importance that every detail in school architecture and arrangement should be held subordinate to the healthfulness, comfort, and attractiveness of the individual classrooms. In the matter of size, it should be the rule to limit the capacity of all regular schoolrooms to 40 pupils, with 35 a more desirable number. Some of the rooms in cities reporting to the United States Chamber of Commerce had an enrollment of from 70 to 100 pupils, 5 per cent containing 50 or more. These conditions are nothing but the product of lack of foresight on the part of the educational authorities in maintaining a building program adequate to the local needs. No teacher can do justice to 50 pupils in a room. Classrooms with a length of 32 feet and a width of 24 feet, provided they are at least 12 feet high, will satisfactorily house not more than 40 pupils. At least 15 square feet of floor space and 200 cubic feet of air space are necessary for each child in the room. The *floors* should be of matched hard wood. *Walls* should be tinted in some light, reposeful shade; light gray or light green are popular

[1] In *School Hygiene*, pp. 30–31.

colors. Dark shades absorb too much light. All painted surfaces, including the walls, should be flat, dull colors, without varnish. Shiny surfaces are common sources of glare, and so are to be avoided.

Blackboards are to be placed carefully opposite, rather than between or beside, windows; they are preferably made of slate, and should be set at a height convenient for the use of the children who are to use them. In primary rooms a foot and a half or two feet from the floor will not be too low; in intermediate and upper grades, the conventional height is satisfactory. Designers of the older buildings felt it necessary to place the blackboards in all rooms at the same height, thus wholly disregarding the needs and comfort of the smaller children. Where the boards are placed improperly with regard to the windows, as is also ordinarily the case in all save the newer buildings, they may be covered with light-colored wallboard or heavy pasteboard and used as bulletin boards, portable blackboards being provided to replace them where necessary.

Natural lighting of schoolrooms. It is no uncommon thing to find among our less modern school buildings rooms with windows on two, three, and even four sides. In consequence of this faulty location of lighting areas, the rooms are perfect pandemoniums of cross-lights, which are very trying to the eyes. Under this arrangement, moreover, children often sit facing windows the constant glare from which is a highly disturbing factor both to ocular comfort and to peace of mind. In older rooms having windows on two sides only, the seating has often been rearranged so that the light comes from one side and from the rear. This relieves the children's eyes from glaring windows in the front of the room, but the teacher, much of whose time is necessarily spent in front of the children, is subjected to continual discomfort. This arrangement fails also, of course, to cor-

rect cross-lighting. Many of the older rooms have an insufficient glass area to provide the proper amount of light desirable in schoolrooms.

The survey of the United States Chamber of Commerce, previously referred to in this chapter, yielded the following data with reference to these points:

TABLE 16. SHOWING CONDITIONS OF LIGHTING OF SCHOOL BUILDINGS

Number of school buildings with insufficient light in all rooms....	23
Number of additional rooms in other school buildings having insufficient light in all rooms..................................	442
Number of rooms having windows children must face............	46
Number of schools having cross-lights in all rooms...............	8
Number of additional rooms in other buildings with cross-lights...	641

The Chamber's comment is: "When out of a comparatively small number of schools, and these in the more progressive communities, so much unsatisfactory lighting exists, it is easy to imagine the damage being done yearly to the eyes of school children all over the country."

In 1922, the Cleveland Board of Education authorized an investigation to determine the illuminating efficiency of the school buildings under its control. A survey of 123 school plants revealed inadequate lighting in 74, or more than 60 per cent. There is no reason to suppose that conditions in this respect are better in other communities.

To achieve proper natural illumination of a schoolroom, illuminating engineers have developed certain standards and rules with reference to orientation, placement, and area of windows which are being followed with much precision by school boards and architects in the planning and construction of modern school buildings. We shall summarize these standards briefly in the following paragraphs.

Unilateral lighting. In the interest of avoiding the vexatious cross-lights, authorities advocate placing the light area

entirely on one side of the room — at the left of the pupils. For all schoolrooms of the conventional size (24 × 32 feet) unilaterally placed windows will, provided they are properly planned, insure abundant light at every desk in the room. In rooms of unusual size and width, such for example as assembly halls, auditoriums, etc., where little close work with the eyes is to be done, windows on two sides may be permissible. The Illuminating Engineering Society recommends [1] unilateral placement in rooms whose total width is not in excess of twice the height of the top of the window from the floor. It is important that window sills be slightly above the horizontal line of vision of the pupils when seated; otherwise light will be reflected from them up into the children's eyes. Since also the light entering the upper part of a window is better diffused through the room than that which enters through the lower panes, it is important that the windows be extended upward as near the ceiling as the frame of the building will permit, and in few cases need they stop further from the ceiling than six inches.

In order to permit the banking of all windows on one side of a thirty-two-foot room, it is necessary to place them close together, with no more space between them than is barely essential for the studs and casings. In a schoolroom of conventional proportions (24 × 32 × 13 feet) it will be possible to place six three-foot windows on one side, with some eight or ten feet of the wall left unoccupied. This area where there are no windows should be toward the front, making it necessary, therefore, for the battery of windows to be pushed back well toward the rear. This arrangement will bring the center of school population at about the center of the lighting area, as indicated in Figure 82.

With windows carefully placed according to these specifications, there will be no opportunity for thoughtless school

[1] *Code of Lighting School Buildings*, 1924.

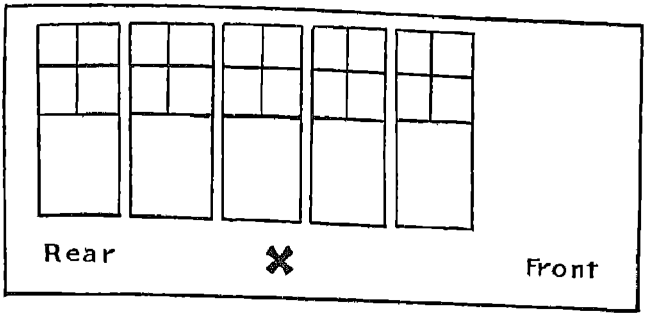

FIG. 82
Showing the correct placing of windows in a room where unilateral lighting is provided.

authorities to place blackboards between them; cross-lights will be practically eliminated; and there will be, under normal conditions, sufficient natural illumination at every desk in the room. The Lighting Code [1] requires a minimum of five foot-candles, and recommends as desirable ten foot-candles of illumination on all desk tops.[2]

Orientation. Unilateral placement of windows obviously makes it necessary to so orient the building that the best light available may be obtained. An eastern exposure is generally considered to be the best for schoolrooms, since the early morning sun can lie in through the windows before the school session begins, thus purifying and flushing the

[1] *Code of Lighting School Buildings*, 1924.

[2] "Every practical source of light has different candle-powers or intensities in different directions, and consequently 'candle-power' is not a direct indication of the total light given out. In order to avoid ambiguity it has been customary in this country to rate lamps in terms of their total light output. The unit used is the *lumen*. The lumen is the light falling upon an area of one square foot all points of which are one foot distant from a source having an intensity of one candle. Such a surface receives an illumination of one *foot-candle;* in other words, one lumen of light flux is enough to furnish one foot-candle of illumination on one square foot." — From the *Code*, p. 3.

rooms with Nature's greatest disinfectant, the sun's rays. Shortly after nine o'clock the sun has moved southward to a point sufficient to permit the full benefit of light to fall through the windows, without the necessity for shades all day long. Inasmuch, however, as economy of space and attractiveness of architecture render it infeasible to so construct buildings that all rooms may have an eastern exposure, the problem of curtaining or shading rooms not so oriented becomes an important one.

Curtains and shades. So far as possible rooms on other than the eastern side of the building may be used for auditoriums, manual training, and other special purposes, reserving the eastern rooms for home classrooms. Even then it will be necessary to use many of the former for this purpose, and in such rooms the greatest care should be observed in the selection of window shades. Direct rays from the sun must never shine upon any desk or work in the schoolroom; there is nothing more trying to the eyes than glare reflected from such surfaces, and even at the expense of reducing the proper foot-candles of illumination in the room, windows through which the sun's rays fall must be provided with shades.

A little foresight and care, however, will make it possible to curtain a room without impairing the effectiveness of its illumination to any appreciable degree. In the conventional schoolroom still, as in most homes, the old-fashioned roller curtain, pulling always from the top of the window, is the rule. Offices and business buildings have long since given these up as highly unsatisfactory, but the school still clings to them. Every teacher has experienced the inconvenience and discomfort occasioned by drawing the shade and so cutting off both light and air from the top part of the window. If she fail to close the window before lowering the curtain, the latter flaps about noisily, and is soon crackled and

torn; if she fail to draw the curtain, the glare of the sun becomes a continual menace to one after another as that luminary moves slowly across the sky. As we have already seen, the upper portion of a window is its best source of light; to cut it off by curtaining is likely to interfere seriously with the effectiveness of the general illumination. If the conventional roller curtain must be employed, let it by all means be made from translucent material of some light shade, such as tan or buff, which will cut off the direct rays but will at the same time transmit and diffuse a considerable percentage of the light. Dark green and dark brown curtains, commonly found in schoolrooms, are obviously wholly out of place.

A far better and more effective method of curtaining is to be recommended in the equipping of every window with two shades, both operated on rollers set in the middle of the window, one pulling upward and the other downward. A variation of this is the placing of one curtain at the bottom and another at the middle of the window, with both operating upwards. Shades so placed may be operated independently, as the need demands; often by curtaining the lower part of a window the sun's rays may be deflected, and the entire upper part, or a large portion of it, may remain uncurtained. Still another excellent type of curtain is attached to an adjustable roller which can be set at any point along the window. Frequently a curtain of this sort, when opened not further than eight or ten inches, is sufficient to exclude all direct rays from every desk within their range. Whatever the type of curtain, translucent material is always to be advised; in rooms where occasional stereopticon exhibitions are given an opaque curtain may be superimposed over the translucent ones, and drawn as occasion demands.

Avoidance of glare. We have referred in another connection (see p. 315) to the dangers arising from glare in the

schoolroom. Among the common sources of glare may be mentioned glazed paper, glossy finishes, and varnished surfaces such as desk-tops, walls, etc. Glare is not only injurious to the eyes but is decidedly irritating to the nervous system; and to insure its avoidance it is essential that all school texts, reference books, and paper have an unglazed, dull finish, and that all painted surfaces about the schoolroom be finished with flat colors in which there is no varnish.

Artificial lighting. In many parts of the country, the limited number of hours of daylight available in the winter months renders necessary the fitting of all schoolrooms with some form of artificial lighting. Lights are also frequently needed on dark days at any season of the year, and in all parts of the country. Use of the school plant in the evening, which is coming to be more common, is conditioned also upon adequate equipment with artificial lighting units.

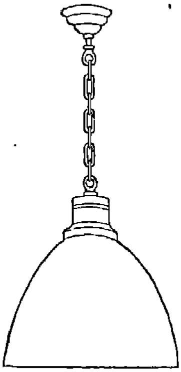

FIG. 83. A DIRECT LIGHTING LUMINAIRE (*The bottom is open.*) *By courtesy of the Illuminating Engineering Society.*

There are in common use for illuminating purposes in public and private buildings three systems of artificial lighting: the *direct*, the *indirect*, and the *semi-indirect*. The first of these systems, direct lighting, is composed of luminaires which throw the major portion of their light rays directly downward upon the work places. Figure 83 illustrates a typical light in this system. The luminaire has usually a bell-type fixture, with an open bottom. Other direct lights may have no enclosing fixtures at all, or they may have enclosed or semi-enclosed ones. In the open-bottom fixture the source of light is plainly visible from below; in the enclosed fixture the light source is completely surrounded by the globe. Table lamps

and bench lights, together with the majority of the fixtures found in our homes, are illustrative of direct lighting. In very high rooms where the luminaires can be suspended twenty feet or so above the floor, as in halls, gymnasiums, and the like, the open-bottom fixtures are satisfactory; for the ordinary schoolroom, however, they set up harsh shadows and cause much uncomfortable glare. Enclosed luminaires, properly constructed, are a most excellent means of lighting schoolrooms. To quote the Lighting Code:

> The enclosed luminaire, when made of good diffusing glass and of sufficient size to insure low brightness of both the luminaire and reflected images, produces satisfactory lighting results from the standpoint of shadows and glare. Furthermore the coefficient of utilization is high. The depreciation, due to the collection of dust and the resultant loss of light, is less than in most systems. Partly because of economy, the enclosed unit is one of the practicable solutions of school lighting problems. It is generally advantageous to select glassware having the horizontal dimension large as compared with the vertical dimension in order to obtain a satisfactory utilization of light.

In indirect lighting, the light from the luminous source is not permitted to fall directly upon the work places, but is thrown up to the ceiling and walls, and by them reflected downward into the room. The fixture used in this method of lighting is an opaque bowl or inverted reflector. Figure 84 illustrates such a luminaire. Indirect lighting provides well-diffused illumination, without strong shadows, but its coefficient of utilization is lower than either the direct or the semi-indirect types. This necessitates the use of more powerful bulbs to produce an equivalent amount of brightness. Ceilings, upper walls, and reflectors

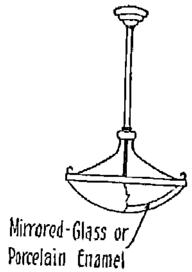

FIG. 84. AN INDIRECT LIGHTING LUMINAIRE

By courtesy of the Illuminating Engineering Society.

must be kept clean and free of dust deposits in order to maintain the original illumination intensity. With these factors under proper control, the indirect method of lighting is very satisfactory for schoolrooms as well as for homes.

Semi-indirect lighting delivers illumination upon the work places, both directly and indirectly. The bowl of the fixture is made of diffusing glass, thus permitting light rays to fall directly. The top of the bowl may be either open, or covered with clear glass, thus permitting light rays to fall upward and be reflected downward from ceiling and walls. The semi-indirect system is designed to direct something more than fifty per cent of the illumination upward to the ceiling, the ratio between the amounts of light thrown upward and downward, however, being dependent upon the character of the transmission of the bowl. When the glass bowl or inverted reflector of the semi-indirect luminaire has a high transmission, the illumination approaches that of direct lighting. To provide the highest efficiency from semi-indirect luminaires, obviously the ceiling and upper walls must be kept white and clean.

Table 17, adapted from the *Code for Lighting School Buildings*, indicates the efficiency of illumination of the desk-tops in a classroom 24 × 32 × 12 feet by each of the three methods described.

TABLE 17. INDICATING THE COEFFICIENTS OF UTILIZATION OF LIGHT IN A SCHOOLROOM OF STANDARD DIMENSIONS

(Reflection factor of ceiling being seventy per cent, and of walls fifty per cent)

	PER CENT
Direct lighting	
Open bottom luminaires	0.47
Enclosed luminaires	0.39
Indirect lighting	0.30
Semi-indirect lighting	
Low transmission bowl	0.33
Medium transmission bowl	0.37

Desks and chairs. We have referred heretofore (see Chapter VI) to the relationship which school furniture bears to posture and the general health. As we saw, while most communities now equip their schools with some type of adjustable desk and chair, by no means do all schools so provided take pains actually to adjust them to the needs of the pupils occupying them. From an economic viewpoint it is an inexcusable waste of the taxpayer's money for a community to go to the expense of installing adjustable furniture in its schoolrooms and then make no use of the advantages which it offers. It would cost very much less to put in benches of the old type, and these would be just as satisfactory as the more modern ones that are never adjusted.

The development of school desks and chairs has been an interesting one. Previous to a generation or so ago most schools were supplied with plain benches and flat desks made of heavy wood. In the older ungraded schools they were usually scaled down so that the highest desks were in the rear and the lowest were at the front of the room; this arrangement was devised on the assumption that the older children could be safely trusted to keep busy in the rear of the room, while the younger ones needed to be more under the teacher's eye — a philosophy that did not always work out satisfactorily! In the case both of many of the old-fashioned desks and of the earlier modern ones that succeeded them, the pupil sitting on one seat worked at a desk which was a physical part of the bench of the child who sat in front of him, just as the one on which he was sitting was an integral part of the desk used by the child sitting behind him. Moreover, each bench usually seated from two to four children. This structural peculiarity was the cause of no little inconvenience, since not only did it place children too closely together, but it also necessitated more or less mutual interference with one another's work.

The first modern desks had sides constructed of iron strips, desk-tops that slanted somewhat, and hinged seats which could be tipped up and permit easier access — and incidentally occasion no little noise. The author still recalls vividly working surreptitiously with screw-driver and oil-can at the hinges of such a seat which he once occupied, in an effort to loosen them up and afford a gratifying means of noise and consternation as the seat banged up and down whenever he rose from or sat down in it! These seats were ordinarily intended to accommodate two pupils. A desirable variation came when the manufacturers reduced their width and turned out individual seatings, although for some years the seat continued to be attached to the desk frame behind it.

The strictly modern school furniture arrived when individual desks, without attached seats, came into use. These were somewhat more slanting than the earlier desks, and replaced the older book-shelf with an enclosed space for holding books and apparatus, access to which was had by raising the desk-top which was hinged to the desk at the back. The earlier attached seat was discarded, and in its place the modern school chair, with hygienically designed back and seat, was developed. When both chair and desk were made adjustable as to height, modern hygienic school furniture came into full being, and has been now almost universally adopted in our cities and larger towns. Many of the smaller schools still retain various older types of equipment. Of 647 schools reporting to the United States Chamber of Commerce, 571 gave "attention to the proper seating of pupils."

Both desk and chair should be carefully adjusted twice yearly to the size and needs of the pupil — in the fall, and again at the middle of the school year. Practical directions for making these adjustments were given in a previous lesson. (See Chapter VI.)

Heating. There is no question but that the temperature in most of our schoolrooms is decidedly too high, during the cool months of the year, to stimulate the most efficient and sustained mental activity. It is no uncommon thing to find thermometers reading as high as 75° F. to 80° F. in schools generally during these months. In a previous lesson (Chapter VII) we discussed the several methods of ventilation in general use, and saw that, whatever the method employed, it is essential in good ventilation that the temperature be kept constantly around 68° F., never rising to 70° nor falling below 65°; that the amount of moisture in the air be kept at about 50 to 60 per cent relative humidity; and that the air be kept continually in motion, although not with sufficient current to cause perceptible drafts. The ventilating problem is tied up intricately with the heating problem, and both have caused ventilating engineers more difficulty than any other arising in connection with the equipment of a modern hygienic school plant.

Steam heating and natural ventilation by means of windows and doors have been generally unsatisfactory because of the undesirability of opening windows sufficiently to ventilate rooms continually in cold weather, and because of the objection of janitors to the loss of heat occasioned by this method of admitting fresh air. The result has quite generally been that windows have either remained closed, or else have only been opened occasionally when the atmosphere became noticeably oppressive.

An investigation as to heating. An important investigation, outlined in Chapter VII, made by Dr. S. Josephine Baker on classroom ventilation and respiratory diseases, suggests, however, that the open-window type of ventilation may after all be more provocative of health and freedom from the common respiratory diseases of the winter months than can be said of the mechanical methods.

This experiment, if it is corroborated by results achieved elsewhere, would indicate that mechanical methods of ventilation tend to favor the development and spread of colds and other respiratory diseases sufficient to keep children out of school from 32 to 40 per cent more than natural or gravity methods, and to foster their spread in milder form among the pupils from 70 to 98 per cent more than these. There are, of course, several sources of error in this experiment. Other factors besides temperature, for example, may have operated in the mechanically ventilated rooms to cause a higher percentage of illness from colds, etc. The conclusion appears incontrovertible, however, that the most healthful schoolrooms in which to work are those in which fresh outdoor air is admitted directly and continuously, without the intervention of fans and humidifiers. It also appears from the study that, as between two types of rooms open to direct natural ventilation, those most nearly duplicating the out-of-doors conditions are distinctly to be preferred, at least on the grounds of promoting greater resistance to disease. For some years we have had such open-window rooms for the anæmic and pre-tubercular; and they have yielded excellent returns in a heightened condition of healthfulness and vigor. Is it not logical to assume that approximations of open-air schools should prove to be most salutary environments in which to place all children?

It is beginning to look as if the human organism, accustomed since time immemorial to the air of the great out-of-doors, but within the past two or three generations imprisoned within doors amid steam coils and "treated" air, were protesting actively against such an unnatural environment, and were endeavoring to reassert its primitive and inalienable needs. Whether this be true or not, the fact remains that the least objectionable ventilation system of our schools and homes appears to be the one that nearest

approaches the atmospheric conditions of the out-of-door world.

It should be said in justice to mechanical systems of ventilation that faulty design, or construction, or installation, together with unfamiliarity and ignorance on the part of those who operate them, are often responsible for at least some of the dissatisfaction commonly found with them.

Commenting upon their earlier experiments, the New York State Commission on Ventilation says: [1]

> . . . The inclination to do physical work, and the inclination to do mental work are diminished by sufficiently high room temperatures. So far as physical work is concerned, our tests show a decrease in actual work performed, when the subject had a choice between working and not working, of 15 per cent under the 75° F. condition, and 37 per cent under the 86° F. condition, as compared in each case with 68° F. . . . These experiments seem to indicate that overheated rooms are not only uncomfortable, but produce well-marked effects upon the heat-regulating and circulatory systems of the body, and materially reduce the inclination of occupants to do physical work. The most important effects of "bad air" are due to its high temperature, and the effects of even a slightly elevated room temperature, such as 75° F., are sufficiently clear and important to warrant careful precautions against overheating.

It seems probable that more light will be thrown upon the whole problem of heating and ventilating by future experimentation, but it is extremely doubtful whether any system of forced ventilation will ever afford as satisfactory an environment from the point of view of healthfulness as is provided by the open air of the out-of-doors, although it is quite within the range of probability that mechanical systems can be developed that will operate more smoothly and with less need for constant attention on the part of the occupants of a room than can be said of the natural method.

[1] *American Journal of Public Health*, vol. 5, no. 2.

Water supply and drinking-fountains. In a later lesson (see Chapter XV) we purpose to discuss such subjects as wells, reservoirs, municipal water works, etc. In the present connection we are concerned only with the sanitary equipment for the delivery of water within schools; i.e., with bubblers and containers. Pure, cool water in abundance is essential to the health of everybody, and school children are no exception to the rule. In the country school of yesterday this need was supplied by the open pail and the common dipper, and in the urban school by the common cup chained to the sink near the faucet. Modern sanitation demands equipment safer and more hygienic as a dispenser of water to school children.

It has been known for some years that virulent germs of disease may cling to a drinking-cup used by a carrier, and may be thence transferred to the mouth of the next individual who places it at his lips. Tuberculosis, tonsillitis, typhoid fever, pneumonia, and other contagious diseases have been proved beyond question to be passed from one individual to another through this means. The General Health Bureau of New York City has recently published[1] a digest of laws prohibiting the use of the common drinking-cup, which indicates that there is wide disparity in the laws of the various States in this regard, and that they are ineffective in many places in compelling compliance with the existing statutes. The bulletin carries on its cover page the following interesting declaration, quoted from the Shelbyville (Kentucky) *News:*

FRIEND OR FOE

The majority of the people consider me a friend; they come to me daily, though I conduct a great germ exchange. Many people come to me daily and exchange the germ of any disease they may have for those of some one else.

---

[1] October, 1924.

The person leaves his germs with me and I give him whatever else I may have on hand.

Among the germs that are left with me for free distribution are influenza, whooping-cough, pyorrhœa, venereal disease, and tuberculosis.

I belong to the great unwashed.

I am a law breaker.

I am a public menace.

But young people, old people, prosperous people, poor people, ignorant and intelligent people, and flocks of school children, all come to my exchange.

I am the *Public Drinking-Cup.*

"The average man," remarks Dr. Dresslar,[1] "requires more faith to believe that dangerous microbes can adhere to an apparently clean drinking vessel, and in this way transmit disease, than was demanded of the ancients for their belief that a salamander was proof against destruction by fire. . . . This is the world of the unseen, and consequently, to many people, the world of the impossible."

The dangers of contagion through the common cup are only slightly reduced by certain types of bubblers in common use on public drinking-fountains. It is no uncommon sight to see people grasp the whole top of the bubbler with their lips, so thin and trickling is the column of water when it is turned on. To be safe, a bubbler should have sufficient pressure behind it when released to cause the water to gush not less than two inches above the fixture, and with a volume great enough to discourage those using it from placing their lips in direct contact with it. Even then, proper use of a drinking-fountain must presuppose a certain amount of common sense on the part of those who seek its refreshing stream. Teachers ought to feel it as necessitous to teach their children how to use a fountain as to drill them in the use of a toothbrush.

[1] *School Hygiene*, p. 109. Reprinted by permission of The Macmillan Company, Publishers.

In equipping a school building with drinking-fountains, the plumbing should be arranged in such a way that an even constancy of water pressure is assured. The bubblers should be of a type which permits the water to drain off, tilted forward somewhat so that the stream cannot fall back directly upon the opening, and made of material that will neither rust nor corrode. A sufficient number of fountains should be set low to accommodate the smaller pupils, and be within easy reach. There ought to be one bubbler for approximately every seventy-five pupils in order to insure the desirable accessibility for all.

Special rooms other than classrooms. No single factor perhaps is a greater handicap to the modern school plant than its lack of space in which to carry on activities not immediately related to the formal instruction of the building. School physicians and nurses must carry on their routine inspection in corridors, cloak-rooms, or in some out-of-the-way corner of the principal's office; and the materials and equipment which they use must be stored wherever there is a cubic foot of otherwise unused room. This condition not only impedes and hampers very appreciably the efficiency of the service of these officials, but detracts seriously from the dignity and importance which their work should occupy in the minds of the school pupils.

The United States Bureau of Education recommends[1] that every school building should have at least one room set apart for the use of doctors and nurses, and that preferably this should be expanded into a suite of rooms consisting of a waiting-room, examining-room, dressing-room, and toilet. In such a suite the doctor may make his examinations and confer with parents concerning remedial or preventive measures which may be desirable in the case of their children; here, too, the nurse may assist the physician in giving

[1] *Health for School Children*, 1923, p. 61.

simple treatment for minor ailments, such as ringworm, pediculosis, etc. It is desirable that the room be fitted with a couch, desk, a pair of scales with measuring rod, a supply cabinet, a filing case for records, a table, chairs, washbowl, with hot and cold water, etc.

In addition to a properly equipped health room or health suite, every elementary school building should include a teachers' lunch- and rest-room; a lunch-room for pupils, which may be used in populous neighborhoods, where pupils return to their homes for the noon hour, as a center for the school lunch and feeding service; a large indoor playroom, where the children may play on stormy days when the weather is inclement on the playground; a principal's office; a janitor's room, and such additional storerooms for supplies, furniture, equipment, etc., as the size and needs of the particular school may determine. It is a shortsighted policy which, when a new school plant is to be erected, fails to canvass the educational trends and include within the walls to be reared all the space and equipment needed to carry on a modern school in the fullest and most accepted sense of the term.

TEACHING POINTS IN THIS LESSON

1. The importance of healthful schools to a community.
2. The older and the newer school plants in your community.
3. Proper natural lighting of the schoolroom.
4. The three types of artificial lighting commonly used in homes and schools.
5. Adjustable and adjusted school furniture.
6. Ventilating the schoolroom.
7. Good types of drinking-fountains, and how to use them.
8. Dangers of the common cup.
9. The importance of the school health room or suite.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Make a survey of some new school plant in your community or city, ranking it on a scale of 10 in each of the following: (1) site; (2) size of grounds; (3) age of building; (4) architectural design; (5) natural lighting of classrooms; (6) color of walls and shades; (7) satisfactoriness of artificial lighting; (8) desks and chairs; (9) ventilation and heating; (10) water supply. Rate some older school plant on the same scale.
2. Prepare a chart showing the ages of all the school plants in your city, assigning five or six buildings to each of several students for this investigation.
3. Draw a plan for remodeling your hygiene classroom to make it fulfill all the conditions of an up-to-date schoolroom laid down in this chapter.
4. Observe and report in class the types of lighting used in the department stores, office buildings, theaters, schools, or other buildings which you visit within the next week. Study the lighting of the rooms in your home, and make recommendations for its improvement where desirable.
5. Under the direction of your instructor, adjust all the seats and chairs of the children in some grade of the practice school. Collect and bring to class as many pictures of various sorts of old and new school desks as you can find.
6. Without modifying or interfering in any unusual way with the ventilation of your assembly hall or some classroom in your main building, keep hourly thermometer readings for a single day, constructing a curve to show your results. What practical methods of improving conditions in the room can you think of?
7. Study the type of bubbler used on the fountains in your school; in the streets of your city; in certain public or semi-public buildings which you frequent.

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CHAPTER XIV

THE HYGIENE OF THE NERVOUS SYSTEM

Importance of the nervous system. Without question, the nervous system is the most highly specialized as well as the most important structure in the whole organism. Without it one could neither see nor hear, interpret nor comprehend, desire nor will, think nor move. Without it external stimuli from the world beyond the body could not be apprehended; without it there could be no memory of the past, awareness of the present, or anticipation of the future; without it one could neither protect himself from danger nor comprehend the presence of danger in his environment. Indeed, were the nervous system to be by some magical pass plucked out of the body of a man, his heart would stop beating, his lungs would cease their respiration, all digestive processes would terminate, and death would occur immediately.

In the lower forms of life — notably of course in the unicellular organisms — there is no need for a nervous system. The amœba, being possessed of but a single cell, is organized on a very simple vegetative basis and requires no integrating nerve pathways to connect up and unify its organism. In certain multicellular forms of life also — like the sponges — no nervous system is necessary, each cell being able to pass impulses to adjoining cells directly. But as we climb higher up the scale of life, to the earthworm for example, we find a simple nervous structure making its appearance in the organism; and as we pass still higher upward in the biological series we find the complexity of nerve structure becoming increasingly great, reaching its most profound intricacy in man.

The great work which the nervous system has to perform in the body is dynamic integration of all its parts. Let us consider a single example, that of a ball-player at bat. To the spectator he appears to be an automaton as he poises his bat, swings it vigorously, hits the ball smartly, and then gallops around the bases home. But let us analyze a little more closely what the nervous system of the batsman is doing during the half-minute or so of his active play. His eyes register upon his brain a simultaneous 'movie' of all the signals and gyrations of the pitcher, as also the pathway followed by the ball from the instant it leaves his hand. As it approaches, not only do the batsman's eyes follow it, but his arms are seen to raise and poise, his back and shoulders to straighten and stiffen, his feet and legs to square off; upon his face at the same time register unmistakable evidences of keen attention and expectancy, and then of resolution. Inwardly he makes a fleeting judgment as to the probabilities of the ball being a 'strike,' and determines to hit it. At precisely the right instant he swings his bat, in precisely the right arc to intercept the twirling object approaching him. Awareness of the contact of bat with ball impels him to whirl off to his base at the right, simultaneously dropping bat and following with his eyes the arc described by the speeding ball. At each base, as he leaps by, he judges anew his prospects of making the next, and entertains wild hopes of a 'home run.' He is aware of the cheering of the spectators; his face flushes as more blood is supplied his working muscles; arms and legs swing in coördinated unison. Triumphant, he slides for the home plate, touching it a scant second before the ball is returned to the catcher. The applause of his supporters initiates little tingles of pride and pleasure within him. Warm, smiling, happy, he turns to observe the fate of the next player.

It was the nervous system of the youth that made it

possible for him to observe and follow the movements of the pitcher, to gauge the direction and line of the spinning ball, to adjudge it to be a 'strike,' to coördinate all the muscles of his body upon the one integrated act of striking the ball, to run around the bases, to feel the thrill of pride that came with successful achievement. It was his nervous system also which caused to be released the muscular energy needed to perform the play; it was the nervous system that speeded up the beat of his heart, that increased the bore of his blood vessels and the rate of his respiration. It was his nervous system that made possible both the physical and the mental adjustments required at each instant of the performance.

We do not, of course, need to go to the ball-field to find illustrations of the integrating, coördinating activities of the nervous system. It is just as much in evidence — although perhaps less strikingly to the observer — in walking, in playing an instrument, in conversation, in watching a sunset, in starting at a sudden noise, in making a decision, in reading a story, in driving an automobile, or in any other form of physical or mental activity. Whatever we do we are able to do because the nerve structures of our bodies control and bend all the organic processes in the direction of achieving that specific end.

Importance of the problem of mental hygiene. There is no more important series of social problems confronting human beings at the present time than those arising out of the disposition and care of the mentally diseased, and the prevention of mental disease in those who are well. A few statistics will be illuminating as revealing something of the alarming extent of insanity and feeble-mindedness in the United States at the present time. In the 163 State hospitals for mental disease operating (1925), there are not less than 300,000 patients. They are being supported at a gross cost of some 90 millions of dollars annually, or a per-

capita cost of $300. These figures do not of course take into account the hundreds of private hospitals and sanatoria that receive mentally sick patients for private treatment; nor do they include the thousands of families in which mentally diseased individuals are shielded and cared for by relatives or friends. Each of the 48 States has at least one State hospital for the insane. New York leads, with 16 such public institutions; Massachusetts is second, with 13; then follow Illinois, with 9; Ohio and Pennsylvania, with 8 each; and California, Indiana, Michigan and Minnesota, with 6 each. Of the 163 hospitals, 10 are for the criminally and dangerously insane, while 4 are psychopathic institutions, located respectively in Colorado, Iowa, Massachusetts, and Michigan.

Not only are these hospitals for the mentally diseased filled to overflowing, but year by year their numbers are increasing, and there are always more persons desiring admission or meriting it than can be accommodated in the institutions. In several States additional hospitals have been authorized, and are in various stages of building at the present time. In 1920, the average number of first admissions to State hospitals was 50,000 persons annually. In 1926, 75,000 persons will enter these institutions for the first time. The economic loss to society from the unproductivity of inmates of State asylums is set at $300,000,000 annually.

In the matter of feeble-mindedness, the figures are no less disconcerting. On January 1, 1910, the Federal Census Bureau reported 20,731 feeble-minded in the 26 States which were at that time maintaining institutions for their care. On January 1, 1923, thirteen years later — 40 of the 48 States were operating institutions for the feeble-minded, with a total enrollment of 42,954 individuals. Undoubtedly much of this 100 per cent increase has been due to the fact

that better facilities for the care of this group have been made available; much of it has also been brought about by the circumstance that feeble-minded individuals needing institutional care are more generally recognized now than formerly through improved methods of mental examination and diagnosis. Again, as in the case of the insane, these statistics do not take into account feeble-minded individuals who are being cared for in private schools and asylums; nor does it include those who are kept in their homes and cared for by relatives. The 42,954 inmates of the public institutions represent obviously those individuals mainly who are nearest to the idiots, and who must in consequence be kept continually under guard, guidance, and supervision. Those slightly higher in the scale — the high-grade imbeciles, the morons, and the border-line individuals — in the main shift for themselves, and while many if not most of them are potential menaces to the community, they are permitted their freedom, and often make the best of citizens, steady workers, and passable parents.

The varying degrees of mental abnormality. Normality, as has so often been said, is but a relative term. To paraphrase an old saw, it might truthfully be contended that "there is so much abnormal in the most normal of us, and so much normal in the most abnormal of us, that it hardly behooves any of us to point the finger at the rest of us." The normal individual, in other words, has his idiosyncracies, just as the mentally diseased individual has his normalities and lucidities. We cannot therefore mark off all human beings into two groups, labeling the one 'normal' and the other 'abnormal.' About the best we can hope to do is to make a rough division, and say that those persons in whom normality and rationality obviously exceed abnormality, are 'normal' individuals; and conversely, that those in whom abnormal and peculiar traits overbalance and weigh

down normal ones, are 'mentally diseased.' Some persons in whom these two great forces — normality and peculiarity — appear to be struggling in a drawn battle must be put down as 'uncertain' cases, although the public is not slow in pronouncing any person in whom abnormal traits appear, as 'crazy.' In this sense, the public condemns itself; for where is the individual who manifests no peculiarities and abnormalities? The wisely thoughtful and sympathetic person will hesitate long before pronouncing any unfortunate individual to be actually demented. This is a judgment in many cases which only the most experienced psychiatrist, after years of study and association with aments, can be relied upon to make; and even he is not able in large numbers of cases to reach a conclusion satisfactory to himself.

Mental disease has unfortunately always been in bad repute. It is a fundamental characteristic for human beings to sympathize and commiserate with those who are sick of body. The dyspeptic is always able to gain a ready and sympathetic ear into which to pour his tale of misery and suffering — and what dyspeptic does not take exquisite satisfaction in informing others of his precarious physical condition? The first symptom of something wrong with the physical mechanism is likely to send one off post-haste to the physician. Stomach ills, liver ills, and heart ills — real or fancied — all drive their victims early and often to the man of medicine.

With those who are mentally diseased, however, it is quite a different story. People look askance at the neurotic and the unstable, and speak in whispers behind their backs. 'Queer people' are too apt to be a laughing-stock and a source of amusement in the neighborhood. Let a person's mind actually give out, necessitating treatment at a hospital for mental disease, and the stigma always clings. "He was

in an insane asylum, you know!" How different from the physically ill person, who never tires of telling others of the unprecedented experience which he had in the hospital! Mental abnormality or peculiarity is about the last thing that any one is likely to confess, even to the psychiatrist; hence it is that early treatment cannot ordinarily be given such sufferers. Thus, unable to bring herself to consult local psychiatrists, an anonymous writer who signs herself 'A Friend in Need' addresses the National Committee for Mental Hygiene,[1] complaining that she "has too much pride to reveal these things to any one," and, after describing her mental state in some detail, asks how she "may keep from going insane." In reply, the Editor of the Bulletin makes the very wise statement that "there should be no pride about a matter of this kind. The patient is in no way to blame for her present mental state, and need be no more humiliated by it than if she had contracted pneumonia."

It is precisely this false pride that is responsible for a great deal of the actual mental breakdown that is ultimately the fate of those who fail to take the proper preventive steps in time. No one of intelligence would for a moment defer consulting a specialist if he were suddenly to develop symptoms of heart disease or of tuberculosis. No more ought he to neglect seeking expert advice when symptoms of mental maladjustment begin to make their appearance. A well-known psychiatrist remarked recently at a clinic that if only the general public could get over its dread and fear of the hospitals for mental disease, and would come to the point of recognizing in them and their staff the logical and natural sources of help to be sought out in time of incipient mental upsetment, a substantial majority of all cases of well-developed insanity might be prevented. There is not the slightest question about the truth of the statement. Mental

[1] *Mental Hygiene Bulletin*, February, 1925.

disease, like physical disease, yields most readily and successfully to treatment when it is in its earliest beginnings.

The supreme importance of childhood for mental hygiene. All this suggests the importance of the observance of the laws of mental hygiene in earliest childhood if individuals are to grow up well adjusted to life and its problems. Leaving out of account for the moment the factor of heredity — which is undoubtedly a profoundly important one in the predisposition to psychoses and insanity — we can safely assert that if the environment and training of childhood were all that could be desired, most of our adult mental disease would vanish away. Since, however, many parents are apt to be careless and indifferent in the matter of building wise habits and attitudes into the mental life of their children, and since they themselves are too often constitutionally wholly unfitted to exert healthful and sane influences over the developing personalities of their children, the latter are prone, in far too many cases, to develop wrong outlooks, bad mental attitudes, and uncertain adjustments which are bound to exert a malign influence later on, when the storms and stresses of life get well under way.

As an illuminating illustration of these facts, we shall quote freely at this point from the case of Priscilla,[1] which exemplifies excellently the baneful influence that may be exerted by a well-intentioned but wholly unfit parent over the mental and emotional life of a child.

> She has the misfortune to be an only child, and her mother never allows her to forget that great things are expected of her. The father, an American, comes from a better family than the mother and has had more education, but he is a 'waster,' whose tendency to drink has lost him one position after another so that he has gone steadily down in the industrial scale. He is naturally quiet, but under the influence of liquor becomes ugly and abusive. The mother came to this country from England in early childhood.

[1] *Mental Hygiene*, vol. IX, no. 1, January, 1925.

Fear, hard work, and constant dissatisfaction have produced in a neuropathic individual a tyrannical chronic invalid.

Priscilla is her only source of satisfaction, present or future. She has guarded her in a frenzied manner, keeping her in so closely, when she was small, that her health suffered. Even then, however, the mother could not bring herself to administer in other than homeopathic doses the doctor's prescription of fresh air and companionship with children. Threats of 'nervous spells' were used freely by the mother as discipline for small acts of disobedience, and they were by no means empty threats, so that Priscilla, who is unusually conscientious, has suffered much from remorse over being the cause of 'nervous breakdowns' or from fear that some innocent act of hers might precipitate one. There has never been much relief from the tense, unhealthy home atmosphere of parental quarrels and fear of the father's physical violence and of the mother's depression, 'brain storms,' or whining reproaches. Added to this, during a certain period in childhood, was much morbid rumination over death, which terrorized her. . . .

Her progress in elementary school was satisfactory, and she was conscious of no particular strain, but adjustment to high school was much more difficult. She minded the noise and confusion and the new methods, especially volunteering in class work, which she could not bring herself to do. She had two failures in her first term, which caused her mother to take to her bed with many a tearful 'How could you, when you know that I would crawl on my hands and knees, or give up my very life for you!' In each term since there has been one failure to which the maternal reaction has been so unvaryingly violent that little satisfaction has been derived from some excellent marks in other subjects.

Meanwhile, Priscilla's companionship was narrowed down almost entirely to that of her mother, who explained plaintively, 'I have tried so hard to be everything to her. She has a radio and lovely books to read. I don't let her go to the library because I want her first to read what I have bought for her — a whole shelf full. Sometimes we go for a walk and stop in a drug-store and have malted milk, and she seems to enjoy it. She gets suggestions for new steps on the radio, and we try them together. She plays basket-ball at the church once a week, and I always go with her. What else does she want?'

. . . School came to be a dread, report time a nightmare, and although Priscilla really wanted to graduate she began to wish that

she might leave school and go to work, as she saw in this scheme a possible chance for a beginning of emancipation from her mother. She brooded and dreamed a great deal over this in her abundant leisure and even when she was supposed to be absorbed in study.

One day a terrible thing for her happened. She had been slow in returning a geometry notebook which she had borrowed from another girl, and the latter was given a bad mark because she could not hand it in when it was called for. Priscilla could not stand that and timorously explained that the fault was hers. Whereupon a procedure considered efficacious in overcoming acts of negligence was impersonally imposed, and Priscilla was instructed to write out her offense, take the paper home for her mother to read and sign, and then return it to the teacher.

Without any effort of the imagination, Priscilla visualized exactly what would happen. She had never before had a note to take home. It would be considered a disgrace, something portentous, reason enough for a collapse, floods of tears, and unceasing censures. Full of dread, she took the note home on a Thursday. No propitious moment to present it came on that day, nor the next, and on Sunday her mother was prostrate in bed for some reason, so there was no question about giving her the awful paper.

Came Monday, school, the unsigned note, a racking situation! On the way to school she met two classmates whose dullness made school a bore, and who accordingly were only deterred from leaving to go to work by stern parents who decreed that they must be educated. To these sympathetic listeners Priscilla told her trouble, and it was quickly decided that they wouldn't go to school at all. For the other two girls truancy appeared as a possible means of forcing their families to allow them to leave for good; for Priscilla, it was a respite, brief, of course, but welcome. The trio loitered along the streets until they came to a church where a funeral was going on and this served as a morbid diversion. They lunched at a bakery and spent the afternoon at Priscilla's house, her mother being away at her work as cashier in a theater.

This program, without much variation, continued through the week, Priscilla realizing that discovery was certain, but being unable to forestall it by confession. On the sixth day a note from school informed Priscilla's mother of her absence, and then began a hard time for both. Not only was Priscilla taxed with the enormity of her crime and blamed for making her mother ill, but she was given to understand that she had forfeited her mother's confidence.

Everything that she did or said was received with suspicion; she was watched from the window and followed on the street. Moreover, she realized that her teachers no longer trusted her, and life looked very dark to this sensitive, timid, hyperthyroid adolescent.

With all these facts assembled, the understanding of this girl seemed a simple matter. . . . Once the mechanism was explained, the teachers were ready to coöperate in treatment, and the mother not only took without resentment, though with bitter tears, a very frank criticism of her attitude toward her daughter, but even asked for definite suggestions as to how she might improve.

The case of Priscilla illustrates well the unhappy effect upon a young child of a morbid home atmosphere in which there is little understanding of the nature and needs of children, and still less competence to minister to them naturally and positively.

Modern psychological theory inclines to the belief that the first five or six years of life are of the most profound importance in shaping and determining the future normality of the individual. In the words of Dr. Sigmund Freud: "The human being is frequently a finished product in his fourth or fifth year, and only reveals gradually in later years what has long been within him." What this means, of course, is that the foundations of the fundamental emotional and mental habits and attitudes are laid during the earliest years of life, and if the environment of the early home years be harsh, or unsympathetic, or otherwise unsalutary, the effects upon the individual are as far-reaching as they are inescapable. If, on the other hand, the child be brought up in a natural environment where every care is taken to insure the building-in of wise habits and points of view and general attitudes, it is equally inevitable that strong foundations for subsequent mental healthfulness will be laid. Let us review for a moment some of the features in the home life of young children that may and very commonly do point in the direction of bad mental hygiene.

Nagging and unsympathetic parents. There is a surprisingly large number of parents who misunderstand and domineer their children, and who rule them with hands of iron. One is almost tempted to agree with the sentiment expressed by a recent speaker who contended that if parents could be chloroformed and put out of the way their children would in most cases turn out all right.

A ten-year-old child is taken by her mother to a habit clinic, and there denounced by her as "an idle, good-for-nothing that sits and mopes in a corner." At school she is a repeater; despite the threats and punishments at home, she is unable to concentrate, going off into fits of abstraction from which she is aroused only by more cogent threats by one parent or by both. Analysis of the case by the psychiatrist establishes the circumstance that the father is a tyrant in the home, ruling the mother with a rod of iron; the mother, in turn, taking the cue from her husband, has domineered the child's very existence since the day of her birth, and whenever her rule has been in danger of stirring the girl to rebellion, the father has imposed a still stronger one. The result has been that she is completely broken and cowed in spirit, no longer either resenting the arbitrariness of her parents — as she did with dire consequences at the age of five and six — nor appearing to be upset by it. As a means of escape from the harshness of the environment, the girl has sought that haven of phantasy which ever beckons to the sorely tried and discomfited child, and finds peace of soul and joy of mind in the realm of fanciful imagination. It was brought out in the friendly conversations which the psychiatrist had with the girl, in his attempts to ferret out the causes back of her periods of abstraction, that in her day-dreaming the child dwells in a beautiful fairy world where her father is a noble king, her mother a kindly queen, and she herself their very much adored daughter, sur-

rounded with friends and playmates who are as real as though they were of flesh and blood. Here is the case of a sensitive child who, unable to make normal and rational adjustment to an environment wholly unsuited to her nature, flees from the harshness of reality by withdrawing into her own self and finding there the pleasures which are denied her in her little external world. It cannot be denied that these delights are satisfying; but it is also true that they are being purchased at the expense of sanity, for there can be no doubt that the child's sanity is at stake.

A harsh and domineering home environment may, however, drive a child into open rebellion and delinquency instead of into phantasy, especially if he be endowed with considerable energy and initiative. The case of Marvin is typical of such an attempt at adjustment. Marvin's father has always been disagreeable toward and unsympathetic with the boy, now sixteen years of age. A believer in the efficacy of strap and rawhide, he has on occasion punished the child almost brutally ever since he was five years old. Marvin, inclined to be self-willed and headstrong, has rebelled openly, and more than once has given his father blow for blow, although the great strength of the latter always prevails, and Marvin emerges from the torture chamber invariably sobbing with pain. The mother is an easy-going woman, but possessed of a terrible temper, which is often vented on Marvin. On such occasions, father, mother, and child commonly shout at one another in voices that can be heard a block or more away. The harshness of the home has driven Marvin away from it as often and as far as he dares to go. At one time he succeeded in reaching New York City, whither his father went to fetch him home. Rebelling against the strictness of the parental yoke, the boy embraces all manner of adventurous undertakings as a means of escape from the stern realities of home. He has been on

probation for incendiarism, and is the ringleader in all mischief and rowdyism of the neighborhood in which he lives. He steals, smokes, swears piratically, and on one occasion at least was brought home intoxicated. His ambition is confessedly to be just as brazenly bad as it is possible for him to be. Mentally, he is of average ability, although he has stood very poorly in formal school work, dropping out at fourteen and loafing consistently ever since. Here is a case similar to the preceding so far as the conditioning influence of the parents is concerned, but quite different from it in the means of escape which the child victim embraces.

Weak, over-indulgent parents. At the other extreme from the harsh, tyrannical type of parent are those who set no bounds to the freedom of their children, permitting them to have their own way on all occasions, and cheerfully yielding to their whims and moods as the easiest way to handle them. Under such unfortunate lack of adequate guidance, the instinctive tendencies are allowed to run wild and often to wreck the prospects of a well-ordered and well-balanced life. By failing to foster in young persons that self-control without which they can hardly hope to surmount obstacles and overcome difficulties later on, the parents and guardians of youth are jeopardizing and sacrificing character itself. It is as disastrous in its ultimate effects upon mental hygiene to give a child free rein as it is to hold him in with an over-tight bit. Who has not seen in family after family children developing most unwholesome attitudes of mind, all because there was no one to guide them with a kindly but firm hand?

It is surprising how quickly children learn to gauge the strictness or lack of strictness of their parents or teachers. Even the two-year-old has learned what range it may expect in its freedom. Thus, there was brought somewhat

recently to a habit clinic a six-year-old child, who was seized often and unaccountably with spells of violent vomiting. Whenever he entered the schoolroom an attack came on, and was so persistent that he had to be sent home. Analysis of the cause by the psychologist revealed the circumstance that the child's mother had always humored him, and that whenever she crossed him he fell to vomiting, and thus got his way. Exactly the reason for the boy's hitting upon this particular means of escape from the unpleasant did not appear — nor is it important: the important thing was that the child had learned to employ an invincible weapon which he did not hesitate to make use of whenever it appeared that obstacles to his will were being placed in his way. School attendance at six was such an obstacle which he did not care to surmount, and he was able successfully to avoid it by having recourse to the particular defense-mechanism that he had developed against just such an emergency. The adult world is unfortunately filled with people who have grown up obsessed with the conviction that their wills must prevail at any cost.

Inharmonious or broken-up homes. Sensitive children are often little short of terrified by the so-called 'family jars.' An unhappy adult sufferer has confessed to the author the agonizing fears and dread that she experienced frequently as a child on occasions when her parents engaged in loud and acrimonious disputes. Many a time she lay trembling on her bed in the darkness, her head covered and the pillow jammed tightly against her ears to shut out the unpleasant scene. If parents realized half the injustice they do to their own children they would refrain from being discourteous toward one another, at least in their presence. Grumbling, fault-finding, nagging, and fighting wives and husbands are often offending more than one another.

Broken-up homes, especially those in which there has

been some stigma like a divorce or a scandal, are also bad influences upon the equanimity of children, who are reminded frequently by their mates of the unfortunate occurrence or condition. Thus a boy of eight, sometime after his entrance upon school life, began to be seized in the morning with the wildest and most unaccountable tantrums which left him so weak that it was quite out of the question to send him to school. Clinical examination and analysis of the case led to the revelation speedily of the root of the difficulty. A child of divorced parents, the boy had been living for some months with his grandparents. At school, his mates began to question him mockingly as to the whereabouts of his father, or whether indeed he had any father. This thoughtless bantering led the boy to dread going to school and to seek some means of escape from it. The tantrums were the very effective means hit upon, and only when the child was removed to a different environment and enrolled in a different school, where nothing was known of his family, did the tantrums disappear and the boy become normal and natural once more, enjoying his school experiences as he had at the beginning of school life two years before.

Scandals and divorces are often more than affairs between two individuals merely: they not infrequently mar and tarnish the otherwise bright outlook upon life which normal children ought always to have.

Undervaluation and disparagement. Children thrive normally on sympathy, appreciation, and encouragement; they wither on disparagement, ridicule, and criticism. There is nothing more discouraging and belittling to a child than to have his opinions, queries, ambitions, and achievements jeered and laughed at by others, and particularly by the members of his own family circle. In the home, of all places in the world, children and adults alike look for and expect — and merit — appreciation, sympathy, and faith.

When, however, a child is criticized and even scolded for his shortcomings, rather than praised for his achievements, there is grave danger that his chances of ultimate success in anything good are being seriously curtailed. In such an environment as this are often laid the foundation stones for a life of neurosis, for which the German language has the very expressive term: *Minderwertigkeit*, best translated perhaps as a 'feeling of inferiority,' or the 'inferiority complex.' Children in particular who have any noticeable physical deformity or abnormality easily develop in such a family circle the inferiority complex. Instead of being led gently but resolutely to have faith in themselves and to make their impress positively upon the world, they lose self-confidence and trust, and, discouraged by the criticism and undervaluation which they receive, turn their attention upon themselves and begin to magnify any peculiarities they may find in their physical make-up; from this point it is but a step to the discovery of mental, or social, or moral abnormalities. The 'unwanted' child, whose parents lose no opportunity to remind him that he was not desired, can hardly develop any great notion of being very important or having any particular mission in the world.

Arising from these and other causes in the roots of an unsympathetic home life, the inferiority complex engenders in its youthful victims a deep sense of inadequacy, incompetence, and distrust of self. This may be, on the one hand, so profound as to paralyze all efforts and all ambition for achievement, causing the mind to turn inward and find compensation in the bright world of phantasy; or, on the other hand, to impel the individual to compensate by throwing himself with tenfold energy into some activity that will demonstrate to the world the fact that in his make-up there are, after all, resources and powers that cannot be disregarded nor gainsaid. The line of action determined

upon may be either constructive or destructive; it may be creative, or it may be criminal. Some of our very greatest men have been stimulated by the limitations of their family and by the inherent defects in their own bodies to compel the respect and admiration of their fellows by the determination and indefatigability with which they have achieved success in their chosen field of work. On the other hand, the criminal records are filled with confessions of delinquents who have not hesitated to lay the genesis of their wrong-doing at the doorway of their own childhood home. There is no responsibility that rests upon the parents of children greater than that of encouraging young people to believe in and have faith in themselves, and in their modest worth to themselves and to others. Lack of such confidence is as bad as an exaggerated sense of one's worth: timidity is as undesirable as conceit.

Prolonged dependence. It is a pardonable trait of the home to enjoy the dependence and helplessness of its young, and to delay as long as possible the coming of the time when the home circle will cease to mean everything to the growing children. Large numbers of parents, however, are guilty of willfully prolonging this normal period of dependence to a point where it is next to impossible for the children to break away and ultimately establish new home circles of their own. Filial devotion is a beautiful and sacred thing, but when it is so manipulated that a child becomes a grown-up 'mamma's boy,' an irreparable harm is in process of being done. In many homes, particularly those in which there is but a single child, the youth is guarded as though he were some rare, exotic plant, not being permitted to find normal social intercourse with other children but restrained and pampered within the walls of home. Thus are wholly false standards set up, and distorted notions of life are cultivated that are all but ineradicable in subsequent years.

Every family circle should strive to develop in the children within it healthy attitudes of mind toward all relationships and situations of life, and prepare them for intelligent and happy participation in them. An adolescent boy who is cautioned and tutored never to think of marrying until he finds some one as near perfection as his mother, with the intimation that such an one can never be found — is being ill-prepared for normal adult relationships and the creation of a new family circle. So, too, daughters who are brought up in the conviction that there are no more men like their fathers are hardly to be expected to look forward to or enter upon the responsibilities of independent living with the right attitudes and viewpoints. There is no more cogent power for good in the unfolding of adolescent character than the idea, wisely cultivated and maintained, that out there in life at no very distant time it will be a youth's privilege and responsibility to found and establish a new circle, based perhaps on the ideals of the old, but by no means hampered and restricted by prolonged adherence to it.

Overwhelming parents. Like those who build closely drawn walls around the home circle, thus creating an artificial world complete in itself, are those other parents who take away all responsibility from their children, making all decisions for them, planning all their activities, settling all their problems, even selecting all their clothes and personal belongings. This unfortunate officiousness of parents makes it impossible for their children to develop good judgment, a right sense of values, and the spirit of self-dependence. Lacking these qualities, they often find it very difficult indeed to adjust to the stern realities of life if and when they are thrown upon their own resources. Over-timidity, discouragement, and often despair, are the inevitable consequences when young people, shielded from every responsibility in the home, must at length train themselves in those

identical traits and characteristics which should have been fostered from earliest childhood.

The school as a factor in the mental health of the child. From the time of his sixth birthday, the child ordinarily passes a considerable number of hours per day within the environment of the school. Naturally many conditions are met with here that make for bad mental hygiene. Among these we may mention two of the most striking. In the first place, lack of *rapport* between teacher and pupil is one of the most unfortunate circumstances from the viewpoint of mental hygiene. Teachers who inspire attitudes of fear in their pupils, or who are everlastingly scolding, nagging, or threatening them, are responsible for no small amount of the neurosis that makes its appearance in the adolescent age. Harsh criticisms, derision, sarcasm, and the like are as destructive to the mental healthfulness of a child as are improper food or foul air to his physical well-being. Fortunately, with the improvement in and extension of training of our modern teachers, the mass of them understand the tremendous importance of harmonious relationships between teacher and taught; there are large numbers of teachers still, however, who if they realize do not heed the truth of this educational principle, but who succeed in making their children uncomfortable, fearful, and even rebellious as long as they sit under them. Timid and sensitive or nervous children frequently develop attitudes of fear and confusion in such schoolrooms which not only make them dread each day's school experience, but which may seriously destroy those very traits of self-reliance, confidence, and determination which the school ought especially to cultivate to the uttermost.

A second unfortunate feature in the modern school, constituted as it is and must apparently be, is the mechanization of routine, with the consequent neglect or even loss of the

individual in the mass. Within a given grade are the sick and the well, the bright and the very bright, the dull and the very dull and the average; the well-nourished and the under-nourished; the capable and the incapable; the strong and the weak; the younger and the older. And hanging over them all like a pall is the necessity in our highly graded system of making certain definite progress at a certain specified rate, and with certain specified, measurable results. If a child has the good fortune to be of average ability, in good physical health, and otherwise well adapted to the work he must do, the results are likely to be excellent, and he will emerge at the end of the year certainly none the worse for his experience, and another round higher on the educational ladder. But what of the child who is not of average caliber? What of the child who is sickly, or mal-nourished, or emotionally highstrung, or innately inferior in mentality? What becomes of him, and how does he emerge at the end of the year? Every teacher and every education-ist knows that our schools are filled, even glutted, with children who cannot adjust to the pace, who limp along somehow through the grades, never happy in their school work, never deriving from it the benefits they should re-ceive, and failing throughout to establish within themselves those social and moral and intellectual traits and attitudes which it is expected the school shall foster in those who come up through it. There are undoubtedly as many misfits in our schoolrooms as there are in our shops and industrial establishments. The only means of relief can come obvi-ously when there are more time and opportunity given to the teachers and the counselors to devote individual study and attention to every child enrolled. Mass teaching un-doubtedly meets a need in the evolution of our educational system. It cannot, however, succeed ultimately in building into universal childhood those fundamental traits that make

for successful living; at best it can be successful with a portion of the children only: many of them are lost in the process, and never find themselves. We are in grave danger of overemphasizing subject, to the neglect and at the expense of boys and girls.

Certain predisposing factors in bad mental hygiene. Heredity. We have, of course, no way of knowing the absolute rôle played by inheritance in the development of mental disease and abnormality. We do know, however, that it is a highly important one, being responsible probably for more than half the cases of mental unbalance and most of the cases of feeble-mindedness, and playing undoubtedly leading rôles in many if not most neuroses that develop in human beings. By far the wisest choice that a child entering upon life could possibly make, if he but had the privilege of doing it, would be that of a sound heredity. Given that, with the formation of common-sense rules of conduct to guide him, he could sail his craft safely and unafraid by the Scylla and Charybdis of mental disease and suffering. Unfortunately, however, one must accept his heredity as he finds it, and make the best he can of it.

There are no darker chapters in human development than those that describe the fruits of bad heredity in families that have been carefully studied. Nor indeed are there any brighter chapters than those written about families of fine ancestral stock that have been a source of benefit and uplift both to their own members and to the wider society outside the shadows of the family tree.

1. *The Kallikak family.* As typical of the first, we have Dr. Goddard's notable study of the Kallikak family.[1] From one branch of this infamous line — initiated when its founder, Martin Kallikak, in a moment of dissipation united his own pure life stream with that of a feeble-minded

[1] Goddard, H. H.: *The Kallikak Family*, 1913.

mate—Dr. Goddard was able to trace 480 direct descendants. Of these only 46 could be discovered to be definitely normal and free from the taint of the blood of the feeble-minded girl. Of the remainder, only the darkest records remain. Thirty-six were illegitimate children, like Martin's son; 33 were sexual perverts and prostitutes; 24 were drunkards; 82 died in infancy, indicating gross family ignorance and neglect, while others were criminals, epileptics, and keepers of houses of ill-fame. It is not extravagant to say that children born of the Kallikak blood had no chance, no opportunity, to hold their own against those of normal heredity; consequently they never rose above the murk and slime of their environment, but wallowed about in it until they died.

The obverse side of the 'scutcheon, however, is brighter. When Martin Kallikak finally settled down, he married a woman whose life stream was as pure and wholesome as his own, and from this union there had issued, up to the time of Dr. Goddard's study, 496 descendants of whom records were available. In the entire line there was not discovered, by the most careful investigation, a single individual who was abnormal in any respect. More than this, says Dr. Goddard, "all of the legitimate children of Martin Kallikak Sr., married into the best families in their State, the descendants of colonial governors, signers of the Declaration of Independence, soldiers, and even the founders of a great university. Indeed, in this family and its collateral branches we find nothing but good, representative citizenship. There are doctors, lawyers, educators, traders, landholders, in short, respectable citizens, men and women prominent in every phase of social life. They have scattered over the United States and are prominent in their communities wherever they have gone. . . ."

Who can say that the children from this branch of the Kallikak line had no chance, no opportunity? Products of

a good heredity, they were reared in a cultured environment, and made for themselves marks in the world that would have been totally impossible for their cousins in the other branch of the line.

2. *The Jukes family.* Another noted study in heredity is that of the Jukes family.[1] Mr. Dugdale, the author, investigating the county jails in New York State, in 1874, was amazed to find in one prison 6 individuals, all related, awaiting trial for various misdemeanors. Two brothers were charged with assault with intent to kill; a male relative was charged with thievery, and his daughter was being held as a witness against him; her uncle was under indictment for burglary; and an illegitimate daughter of his wife was being held on a charge of vagrancy. Investigation revealed the astonishing fact that of 29 male relatives of these 6 persons, 17 were criminals, 15 having been convicted in the courts at one time or another. Mr. Dugdale was able to trace the infamous line back to one Max, who lived in the last half of the eighteenth century, and who was a worthless ne'er-do-well, averse to work and surrounded by a numerous progeny. With indefatigable patience the investigator succeeded in uncovering the records of 540 individuals related by blood, and 169 others by marriage, to the Jukes line, a total of 709 persons. The study revealed 280 known paupers, 140 criminals, 250 arrests and trials, 60 constitutional thieves, 50 prostitutes, and 7 murderers, while it was estimated that some 300 died in infancy. Up to 1875 the cost to the State of maintenance, prosecution, and loss of production entailed in this notorious family line was more than one and a quarter million dollars. The Jukes were not primarily a feeble-minded line, but rather a family of worthless, lazy, unproductive people whose only contribution appears to have been "unending crime, pauperism, disease,

[1] Dugdale, R. L.: *The Jukes*, 1910.

viciousness, and immorality." With such hereditary predispositions, and reared in such environment, what chance had any of the Jukes children?

3. *The Edwards family.* Fortunately there are other studies, equally elaborate, of fine heredity, proving that the good and the uplifting can be handed down through the generations, as well as the bad and the debasing. Possibly the most notable of such investigations is that of the family of Jonathan Edwards.[1] Dr. Winship was able, in 1900, to identify 1394 descendants of this line; following is the roster: 295 college graduates; 13 college presidents; 100 clergymen; 60 physicians; 75 army or navy officers; 60 writers, 18 periodical editors; 10 lawyers; 30 judges; 80 public officials; 3 United States senators; several governors, mayors, and ministers to foreign courts; 15 railroad presidents; and a vice-president of the United States. So far as could be ascertained, no descendant of Jonathan Edwards was ever convicted of or charged with a crime. With such substantial heredity, and reared in environments corresponding, how could children born of the Edwards blood fail to make their marks in the world?

Heredity sets the first and ultimate limit to the achievement of every one. It would be idle to attempt to differentiate between the relative importance of heredity and environment in the making of a life: very frequently good heredity and environment go together, as do also bad heredity and bad environment. In instances where they are not similar, it is impossible to predicate what the effect will be upon the individual. Dubious heredity is certainly a thing to be regretted, and one of the prime aims of mental hygienists and eugenists is to so educate people to the supreme significance of blood as to discourage the initiation and the perpetuation of undesirable strains. The victim of

[1] Winship, A. E.: *Jukes-Edwards: A Study of Education and Heredity.*

poor heredity has less than half a chance in the storm and stress of modern life to steer sanely and steadily a safe course and a smooth voyage. Fears, anxieties, inferiority complexes, nervousness, neurosis, emotional overstrain, instability, breakdown, and often insanity are far more readily acquired by those who inherit tendencies in these directions than by those who inherit strength and the power to resist them. When the exigencies and the crises of life impend, it is the former who founder oftenest in the depths, while the latter are more likely to sail the troubled waters without ill-effects.

Bad personal hygiene. Yet we must not lay all mental unbalance and instability at the doorway of heredity, blaming our ancestors and forbears for such misadventures as overtake us. At most, heredity is but a determining tendency whose power can often be mitigated if not broken quite by a wise regimen of life. It is a fact abundantly corroborated by statistics that alcohol, for example, is responsible for half the insanity which drives persons into hospitals for mental disease, and while defective heredity is undoubtedly often the factor that makes for ease in the formation of the liquor habit, there can be no question that bad company and ineffective operation of the will-power are the predominant urges in this direction. It is probably reasonably within the power of all persons, save those of most defective and negative heredity, to so regulate their lives as to avoid not only the mental dangers of alcoholism, but those attendant upon all other vices and immoralities. Few people ever discover the real power of will, to say nothing of cultivating and developing it in their own self-interest.

It must be taken for granted, of course, that it is a harder battle for those whose environment is not all that could be desired, to resist evil, to avoid mental, and emotional, and

moral vortices, and to work out an ordered life, than it is for those in whose neurones are faint urges in the opposite direction. The battle is not, however, necessarily a losing one. The great problem for everybody, regardless of his heredity, is to discover and hold to such rules of wise conduct as will enable him to live harmoniously and well adjusted to all the circumstances of his environment.

Unhygienic physical habits are especially to be avoided by those who would cultivate wise mental adjustments. The subtle parallelism existing between the physical and the mental is a condition well understood by the medical man, and better still by the psychologist. Toxins within the system; debilitating effects of lingering disease; intemperance in every form, gastronomic, alcoholic, and sexual; insufficient rest and sleep under hygienic conditions; overwork and underplay; general neglect of organic health — these are undiluted evils in the life of any individual who is seeking a calm and satisfying mental life. Of prime importance for everybody to avoid, they make easy victims of those who have in their constitutions the leanings toward neurosis and unbalance, and before them these people fall like grass before the scythe of the reaper. Yet our human society appears to be more and more tending to promote those very unhygienic physical practices which the race can least successfully withstand. This is becoming increasingly an age of intemperate living, late hours, and intense activity, in which the sheer resistance power of an organism fashioned in the great open laboratory of Nature finds itself all too commonly overpowered and unable to make the adjustments needed. Man is a creature of the plains and the camp-fire, and he cannot be transplanted into a twentieth-century environment without protest and rebellion on the part of his physical mechanism. Witness, for example, the now very common incidence of 'nervous breakdown,' suffered by

youths of eighteen, and by their mothers and fathers, and aunts and uncles, and cousins as well — a tragic commentary on our vaunted civilization and the impossible demands it makes upon its patrons!

Bad mental adjustments. More direct contributions to bad mental hygiene are made of course by unhealthy attitudes toward life and its problems and its activities. There are a number of sources of bad mental adjustments, a few of the more important of which we shall here describe.

1. *Worry.* Worry, which has been defined as "a complete circle of inefficient thought whirling about a pivot of fear," is one of the greatest depleters of nervous energy known, and one of the most common contributing factors to mental disease and instability. G. Stanley Hall was able to tabulate several hundred distinct fears or phobias that were admitted to be the bane and curse of many persons who responded to his questionnaire. Included in Dr. Hall's list were morbid fears of death, of disease, of failure, of incompetence, of sin, of fire, of water, of desertion, and scores of others. Obsessed with any morbid fear of this nature, an individual in the grasp of the fear demon is half defeated already in building and living a normal existence. Fears, worries, and anxieties are as inimical to mental health as are colds and fevers and exposures to the physical.

2. *Improper balance between work and play.* A second source of bad mental adjustment is to be found in the maintenance of an improper balance between the work life and the play life. All work and no play not only makes Jack a dull boy but an abnormal and ill-balanced man. The human machine appears not to be constructed — marvelously fool-proof as it is — to perform under full steam without its periods of running idle. Every psychiatrist knows that overwork, long-continued and exacting, exhausts both body and mind. Too much care cannot be taken by him who

would get the most from and contribute the most to life to maintain a sane balance between these two great agents. The thoughtless man of affairs who neglects home, friends, and exercising place, to devote the more of himself to his counting-house, is only half living; and the mad pleasure aspirant who neglects business and hard work to devote the more of himself to play and idle sociabilities is likewise only half living. Every human being who is to be successful and respected by others must be activated by a burning purpose to achieve and to accomplish, and at the same time glad anon to throw off the compelling load and play as children play, wholesomely, eagerly, and fullheartedly. The greatest hewers of destiny and the greatest makers of history have always been the greatest players as well as the greatest workers.

3. *Lack of an objective.* Dr. Burnham[1] postulates for every individual, who is to live normally and in the fullest sense, a task or goal, a plan by which to achieve it, and freedom in which to work toward it. It is the absence of any definite and tangible objective in life that unquestionably furnishes one of the major sources of bad mental adjustment. Fancy a day's work performed without any purpose or end in view; fancy then a lifetime's work performed similarly without goal or purpose. Man needs to be activated with a high purpose if he is to live and build intelligently. Much of the trouble in certain layers of society to-day, and in many individuals in all layers, is due to the utter absence of worthy goals and objectives to be reached. Aimless drifting, without chart or compass, never bore one in safety into a far harbor. Let every one then conceive some laudable goal, and bear toward it unfalteringly. It may be an educated mind, or a beautiful home, or the ennobling of another life, or the winning of modest but well-

[1] Burnham, William H.: *Mental Hygiene*, 1924.

deserved fame; or it may be the cheerful doing of the homely tasks set for us by the circumstances of life in which we find ourselves. Goals that are achievable for one individual are wholly different from those that are achievable by another: the important thing is that there should be tasks and goals in every life.

4. *Overstimulation of the emotional life.* A fourth contributing factor to bad mental hygiene is that overstimulation of the emotional life which is unquestionably a most evil influence in the lives of young people in particular in the present age. Late hours, elaborate school social affairs, and moving-picture theaters on every corner, contribute and combine with other allurements to make anything but hygienic mental environment for the nurturing of youth. There is much to be said in favor of the old-fashioned quiet and restfulness in which the grandparents of to-day's children were brought up. On the other hand, a certain amount of stimulation is essential in any environment to offset the inertia into which people, lacking it, so readily and easily fall. What parents of to-day most need is sufficient intelligence and cleverness to regulate in a measure the stimulation to which their children are naturally exposed, in order to insure that they may grow up with wise habits of rest and relaxation, and be able to see the activities of life in their proper relationships. Grown-ups, too, are equally open to the dangers of overstimulation and excitement in these days of speed, thrills, and other intemperances that beset us. It would certainly be illuminating if we could know and gauge the rôle played by overstimulation of one sort and another in the initiation and development of neuroses and mental disease in this twentieth century.

5. *Lack of interests, fads, avocations, hobbies.* The lack of these supplies another predisposing element in bad mental hygiene. Sanity and peace of mind are to be found

in those relaxational activities to which we turn on occasion as fascinating by-paths of the main thoroughfares we tread from day to day. Golf to the cooped-up man of business is as essential to the maintenance of health and good-humor as are the exhilarating and fascinating plays and games of childhood to school boys and girls. They are a means of escape — not from the tread-mill of work, for that is in itself a wrong mental attitude that so regards the daily round of labor — but rather from the close and narrow concentration necessitated by the serious work of gaining a livelihood and hewing out our life goals. Poor of mind and dwarfed in spirit indeed is the man or woman who cannot find charm and refreshment in a book, or a picture, or a collection, or a sport, or a bit of research, or travel, or music, or hiking, or in some other of the innumerable activities that call one away for the time being from the beaten tracks of daily life.

6. *Unsocial attitudes.* Among other factors leading to unfortunate mental adjustments should be included unsocial attitudes, which impel persons to segregate themselves and pass their days unmellowed and unhumanized by free and intimate and sympathetic contacts with their fellows; fanaticisms of one sort or another — religious, political, social, and the like — which narrow and sour the mind, make for bigotry and delusion, and warp judgment and outlook; and self-pity, which reduces one's work to a form of drudgery more exhausting than that sustained by any other person in one's circle of acquaintances, dulls one's ears and heart to the needs and appeals of the world beyond the doorway, and makes of one a hypochondriac and a bore.

What the school can do to promote mental hygiene. If it is true, as we have intimated in an earlier caption, that the time to start building hygienic minds is in childhood, it would seem that the school as the prime social agent constituted to mold the individual into a desirable and valuable

future member of society, should be particularly solicitous in this regard. We may make brief mention in the following paragraphs of some of the specific things which the school can do in this connection.

1. *Discover and correct incipient physical defects.* One of the easiest things that the school can do to promote the mental health of its pupils is to look after their physical well-being. The direct relationship between eye-strain, impacted teeth, dental caries, and obstructions in the naso-pharynx, for example, and wholesome mental adjustments has been pointed out again and again by schoolmen and psychologists alike. Nervousness and instability of mind very frequently arise from physical defects and abnormalities of this sort. An efficient system of health inspection and clinical service is therefore indispensable in the school that is to do its full duty in safeguarding the mental health of its pupils, and establish in them secure physical foundations for a safe mental superstructure.

2. *Prevent infectious disease.* Undoubtedly a major cause of neurosis is the presence within the blood stream of the irritants resulting from specific disease. These toxins not only debilitate the organism and lower its resistance, but act without question as a prime source of irritation and reflex stimulation of the nerve structures, which may be distinctly disastrous to normal mental serenity, particularly in children. In addition to the discovery and correction of physical defects, the school health organization must also be vigilantly on the watch to detect the early symptoms of disease, and to use every precaution to prevent its spread among the school population. Prevention, as we have stated before, is the watchword of modern hygiene.

3. *Teach and foster wise health habits and attitudes.* In line with their actual inspectional, corrective, and preventive activities, the school health workers, and notably of course

the teacher herself, must pay strict and tireless attention to the encouragement and development of correct habits and attitudes toward personal health in their pupils. It is useless to surround children with every safeguard in the way of preventing disease and defectiveness, without at the same time training and preparing them to take care of their own best welfare when they have passed beyond the secluding doors of the school out into life. That school will have failed signally in its responsibility that fails to build into the lives of those who pass perennially through it wise and effective controls by which they may keep their physical machines always at the maximum of their efficiency.

This is an idea, it is true, which few people even approximate; it is, however, an ideal that must be increasingly striven toward if the human race is to maintain itself vigorously under the more and more complex and devitalizing influences of advancing civilization. Habits of cleanliness, play and exercise, temperate eating and drinking, avoidance of excess in everything, strict care of the organs of sense, vital organs and functions, and occasional consultation of the expert — these are essentials in the mosaic of health and should be consistently built in during the formative period.

4. *Cultivate right attitudes of mind.* Sane and rational ways of thinking, sympathetic altruism and common-sense attitudes toward society, and other people and customs, right attitudes toward one's work, obligations, and responsibilities; toward one's home, country, and Maker — these are of the highest importance in the shaping and fashioning of the well-ordered and well-proportioned life. Persons who are unsocial or anti-social, who lack faith in their fellow men and in the ultimate goodness of human life, who dislike their work, shirk their duties and obligations, and are everlastingly at odds with friends, relatives, government, and even with God Himself, are hardly to be given a clean

bill of mental health and sanity. The school is not only the earliest, but it is also the most logical and effective agency in the promotion of wise and proper mental attitudes and adjustments.

5. *Provide for the development of broad human interests.* There are innumerable people in the world whose sun rises and sets in themselves, whose interests are limited to the narrow range of their own little world. Such persons can hardly be expected to understand, not to mention sympathize with and lend their aid to, those who have other interests or are actuated by other ideals than theirs. There is perhaps no element in human experience more conducive to mental health and sanity than the sympathetic awareness of and interest in the problems and strivings of other human beings. A normally rational individual finds in the experiences of his fellow men interesting and valuable lessons for himself, and out of his own experience is able to appreciate and understand their failures and their successes. It is this sheer humanness, this active participation in the struggles and strivings of men, that makes for sanity and healthfulness in the mental life.

To this end, it should be a high privilege and supreme obligation of the educative forces of the schoolroom to broaden the horizon of young people until it comes to include all the world, to arouse in them a keen interest in following the unfolding of the great human drama on its widely separated stages, and to show them their own oneness with all that is human everywhere. When the time has happily come that citizens of a community and a state are also keenly aware of a wider citizenship in a nation and a world, international jealousies, misunderstandings, and bunglings will be far less common and less dangerous to the peace and amity of the world. Mental hygiene would turn a man's solicitude outward from introspection and self-sympathy,

and attach it to the needs and the deeds of humanity everywhere.

6. *Provide the stimulus that comes from success.* Failure is one of the most deënergizing and discouraging forces known. Most persons have not the tenacity and the 'try-try-again' attitude of a Bruce, a Napoleon, or a Lincoln, but find it exceedingly irksome, if not indeed impossible, to rise from the depth of failure and defeat. As Dr. Burnham has repeatedly pointed out, there is nothing so calculated to destroy a child's ambition and turn the edge of his enthusiasm as continued failure in his tasks. Such being the case, it behooves the school to so manipulate the activities of every child that in some connection or other he may feel often and unmistakably the thrill and stimulus of success. This is by no means a thing easy to bring about with all children, but there is no question about its desirability.

When our schools are at length organized on the proper basis, where the talents and capacities of each pupil are discovered early in his career, failures and defeats in the educational program will be far less common. At present, however, with our mass system of more or less mechanized instruction, under which the traits and tastes of the individual pupil are lost or wholly disregarded, it is inevitable that many children fail to find themselves, never feel the impetus of successful performance of anything, and drop out of the system as soon as the law permits — self-confessed and apparent failures at the very threshold of life where, if ever, reasonable anticipation of success ought to obtain. Notwithstanding this obvious weakness in our educational machinery, the fact remains that the careful, sympathetic teacher can, with a little care and solicitude, demonstrate to the occasional satisfaction of even the dullest pupil the fact that he possesses some talent that is praiseworthy and deserving of special mention and recognition. In any

event, however mediocre the performance, the effort back of it can often be praised wholeheartedly, to the immense pride and encouragement and gratification of the performer.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Write out, as accurately as possible, a description of the neural action involved in the process of threading a needle, or in steering a boat.
2. Under the headings spinal cord, medulla, cerebellum, cortex, and autonomic nervous system, list as many functions controlled by these structures, respectively, as possible.
3. Look up the statistics bearing upon mental disease in your own State. Locate the State hospitals, and find the annual cost to the citizens for the maintenance of these institutions.
4. Similarly look up the statistics for feeble-mindedness in your State, locating the State schools, and finding the annual budgets for these institutions.
5. Do you know any family or families where it is apparent that children are being brought up under conditions not conducive to good mental hygiene? Cite such cases in class, and suggest improvements which you think might be made in the environment of such children.
6. Have you ever known of cases where undervaluation and disparagement of the opinions, ideals, or work of young people have led to disastrous results?
7. Criticize your own elementary and high-school experience from the viewpoint of its influence upon your own mental hygiene. What factors were positive and healthful? What were negative and unhealthful?
8. Cite some case of bad mental adjustment that you know of, and indicate the effect upon the individual concerned.
9. Make a list of 10 things you can do as a teacher to promote the mental health of your pupils.

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CHAPTER XV

COMMUNITY HEALTH PROBLEMS

The wider significance of public health. Thus far in this book we have been concerned almost exclusively with the health of the individual, without reference to the hygiene and sanitation of groups of individuals. We have surveyed the more important physiological processes going on in the human body, and have made an attempt to discover how best to keep the organism healthy and vigorous, paying special attention always to child hygiene.

We are now to turn our attention away somewhat from the individual, and direct it upon the group or community of which the individual is always a part. After all, the community is but a collection of individuals, each of whom, from a health point of view, is either an asset or a liability to it. Those who take wise precautions to safeguard and protect their own health are by that token contributing to the general public health, and represent distinct assets to the neighborhood and the city or town in which they live. Those who, on the other hand, are careless or indifferent in matters of personal health, and who are continually running all sorts of risks from exposure, late hours, and other unhygienic practices, are undermining the general health of the community and are to be reckoned as distinct liabilities to it. In no sense is every man his brother's keeper more truly than in matters pertaining to healthfulness. A single carrier of typhoid, diphtheria, syphilis, or any other strictly preventable disease, becomes a menace to every one with whom he comes in contact, and some innocent persons inevitably suffer through his carelessness or negligence. A chain of people is no stronger than its weakest individual link.

Problems arising from concentration. As long as mankind lived in isolation or in sparsely populated regions, the whole question of public health could be largely neglected. Social intercourse was slight, and the whole group of health problems arising from the herding of a million or more people within the limits of a single city had not presented themselves for solution. Even in modern rural communities, while of tremendous importance, these problems are relatively simple, since the possibilities of extensive infection from a single individual or a single home are in no wise comparable with those which must be reckoned with in metropolitan districts. Within the past generation there has been in this country a most amazing and widespread movement away from the rural regions to the densely populated cities, so that, at the present time, well over half the population of America is clustered together in the urban centers. Better opportunities for work, schooling, and social and recreational activities have been among the prominent causes back of this twentieth-century hegira, with which there has been nothing comparable in extensiveness heretofore in history.

The problems arising from this concentration of human beings in great cities have been all but unresolvable. Adequate housing, satisfactory intercommunication and transit, parks, schools, and playground facilities can only be had in the large cities by the constant exercise of foresight and ingenuity on the part of a large number of public officials and representatives who are entrusted with the responsibility of making the entire community comfortable and healthy. Even with the best of good intentions, however, there is some disquieting evidence to the fact that great cities cannot continue to add stories indefinitely to their sky-scrapers, and subways and elevated ways to their streets.

Whatever is to be the future solution of these difficulties,

the basal importance of community hygiene and sanitation to the welfare and comfort of the dwellers in every city, large or small, cannot be overemphasized. Health conditions every worth-while activity of every individual in every community in the land. It would be the height of folly for a city to tunnel its streets and rivers, to rear its ponderous sky-scrapers, and to build up great business and industrial or commercial enterprises without paralleling every advance in magnitude of expansion with steps adequate to guarantee that its workers may be kept reasonably healthy and able to perform the tasks set for them to do.

A major task of a modern city. Safeguarding its citizens from disease is, from the viewpoint of money expended, one of the major tasks of the modern city. In the year 1924, New York City spent over thirty-one millions of dollars, or one twelfth of its entire budget, for protection and conservation of the public health. Notwithstanding this outlay, the Chairman of the New York State Commission on Housing and Regional Planning, writing recently in the *Survey*, says:

> In spite of sanitary codes, tenement-house laws, and various other urban reforms, the prospects for decent human living have become distinctly worse in New York City during the last generation. And New York, unfortunately, represents the goal toward which all our bigger centers are striving with might and main. To-day half the population of Manhattan are living in quarters which are below the standard fixed as safe and sanitary by the tenement-house law of 1901. The new tenements meet a minimum standard of sanitation and ventilation; but they do this at a price beyond the reach of two thirds of the population.
>
> Superficial observers talk of this housing breakdown as if it were a product of the war. On the contrary, there is a chronic deficiency that has been piling up in every great city — in London, Paris, and Berlin, as well as in American cities — for the last hundred years.

When the United States Government set about the stupendous task of building the Panama Canal, it sent sani-

tarians and health experts into the Canal Zone before it sent down its dredges and steam shovels and dynamite. France had failed a generation before in achieving the same goal of uniting the Atlantic with the Pacific because she failed to reckon with the factor of health as it affected the workers whom she sent to the Isthmus; but because the sanitary engineers first banished yellow fever from the entire region, when the American workers arrived they were able to prosecute the great task to a successful conclusion. The basal essential to every undertaking, whether it is building a canal, or running a machine, or keeping a ledger, is health; everything else is secondary in the vital sense that it is dependent upon that.

Relationship of educational hygiene to public health. In a strict sense this volume is concerned rather with educational than with community hygiene. Since, however, one of the significant divisions of educational hygiene has to do with the teaching of health habits and attitudes and health ideals, it is essential in the interest of completeness, as well as for the sake of extending the meaning of health to its fullest proportions, that the elements of community hygiene and public health should not be neglected. It is quite as important for children and young people to be taught something of the latter as it is for them to learn the laws of personal or individual health; it is decidedly ill-balanced and one-sided training which stops with the periphery of the body, and fails to take into account those wider contacts of human society which have such an important bearing upon healthy living.

The significance of disease. Without any question, man's greatest enemies are invisible to him. We shudder at the holocausts of war and famine, but we take little thought concerning the toll of disease and the suffering attendant upon it. We lament the frightful loss of millions of lives in

the World War, and many thoughtful people are frenziedly trying to find an acceptable way that will avert the repetition of such a tragedy on an even greater scale in the future. We appear to be not so alarmed, however, over the fact that in a single year (1918) influenza killed as many victims as did four years of war itself. In our own country alone, more than 500,000 of our citizens succumbed to that disease in 1918. This represents ten times the number of our soldiers who were killed in action or died from wounds in 1917 and 1918 in Europe. In the registration area of the United States, in 1920, 182,000 deaths occurred from influenza and pneumonia; 100,000 from tuberculosis; 75,000 from cancers; 75,000 from nephritis; 50,000 from diarrhœa and enteritis; and 15,000 each from diphtheria, diabetes, and syphilis. The deaths from these eight diseases alone in our country, in 1920, exceeded by 50,000 the total number of soldiers killed in battle, dying as a result of wounds or disease, and deaths from all other causes in both the Union and Confederate Armies of the United States, in 1861–65. It is when we pause to consider the ravages of diseases in relationship to the ravages of war that we are compelled to appreciate the terrible significance of the former.

The great battles of the future, if man is to escape annihilation, are to be fought not on battle-fields, in trenches, in the air, or on the water, or beneath it, but in the bacteriological laboratory, in the clinic, and in the hospital. The real heroes of the future will include the microscopist and the bacteriologist and the medical experimenter, although it is doubtful whether these ordinarily modest personages will inspire as much tumult and shouting as do those more popular and spectacular fighters who engage in mortal combat in the field. Human life must become increasingly, as society becomes more highly integrated, a struggle between man and microbe. Victory will rest with the side which puts

forth the most persistent effort. There is no question as to the effort which the microbe will expend in its perennial assault on mankind; we dare not let the issue go by default: our defense must be as pertinacious and as determined as the enemy's offense. We have this advantage: the incalculable assistance of reason and scientific equipment; we have this disadvantage: the inertia of the average individual wherever and whenever matters of health are concerned. Pasteur said long ago that it was within the power of man to rid himself of all parasitic disease. Whether the combined intelligence and coöperation of man will eventually be enlisted or not, is problematic. Certainly an enemy which is able with one fell swoop in a single winter to kill 10,000,000 persons — as the influenza germ did in 1918–19 — is not an adversary to be put lightly aside. The world could not stand many repetitions of such a calamitous onslaught of the microbe.

Pathogenic and non-pathogenic bacteria. Altogether thus far some 1500 or more kinds of bacteria have been noted and described. Of these, fortunately the greater part are classifiable under the nomenclature: 'non-pathogenic'; that is to say, they are not specific causes of disease. Some of them are harmless or neutral; others of them are positively beneficial. Among the harmless varieties are those that exist in multitudes in water, in the air, and generally throughout nature; those that are directly beneficial include the zymogenic bacteria, which are responsible for fermentation, the souring of milk, etc.; and the nitrogen-fixing bacteria which perform important work in the destruction of animal matter and in the preparation of food for vegetable life in the soil. The human intestine swarms with beneficial bacteria whose function it is to decompose the waste products in the dietary. The purest milk contains neutral bacteria in tremendous numbers, as does also the cleanest and safest water.

It is important in our study of personal and public health, therefore, to understand that it is only relatively few of the micro-organisms that are able to grow in the human body, and that of the myriads found flourishing outside, but a small number are pathogenic, and so dangerous to human life. These facts do not of course detract from the constant menace which the disease-carrying varieties of microbe present to man; they rather tend to indicate the necessity for his combating these relatively few dangerous forms with all the means at his disposal.

How do pathogenic germs enter the body? The germs of disease cannot originate spontaneously in the body of the victim; they must enter it at some definite point, after passing from the body of an ill or infected person. By far the most common point of entry of these micro-organisms into the human body is the air passage through the nose and throat. Indeed, if some brilliant experimenter could miraculously devise a way of safeguarding these doorways to the body, the burden of communicable disease would be largely lifted from mankind. The warmth, the moisture, and the darkness of the naso-pharynx provide the three essentials for the development and flourishing of bacterial life, and once germs can find a vulnerable point on these membranes they establish colonies upon it and proceed to grow and multiply, throwing their toxins into the body to weaken or impair it, and often to destroy it, before it can rally against the invaders.

Another point of entry to the organism frequently furnished the ever-waiting microbes is to be found in wounds, large and small, which it suffers from time to time. As Walters puts it,[1] "Every wound is a breach in the wall through which the foe may enter." A break in the skin should always be considered a serious thing, and treated

[1] In *Principles of Health Control*, p. 321.

accordingly. It is never possible to predict what the consequences of sticking a pin or needle in the hand, running in a splinter, knocking off a piece of skin, or bruising the skin may be. Sometimes a very painful wound, receiving no care, heals rapidly and produces no ill-effects; at other times the merest scratch of the surface of the epidermis may lead to infections, like boils and even tetanus. It all depends upon the circumstance of microbes finding their way in through the abrasion, either from the object that inflicted the wound, or subsequently through carelessness in protecting the wound from them. Wounds from fireworks are especially dangerous because of the likelihood of tetanus developing from them. Bites or scratches inflicted by animals, notably the dog and rat, also frequently cause serious infections, hydrophobia being the most dread. Ill-fitting shoes may cause the development of blisters, ingrowing nails, etc., and these local irritations afford opportunity always for infections to enter the body.

A third means of entrance for disease is afforded by the bites of insects, notably the mosquito, which is the disseminator of malaria and yellow fever. In addition to the ever-present possibility of the germs of disease being introduced directly into the body by insects, wounds produced by them are usually irritating, and there is a strong tendency to scratch the skin vigorously with the nails in order to relieve the itching; in this way germs clinging about the fingers and under the nails may be scratched into the skin, along with dirt particles, thus increasing the irritation and the likelihood of infection.

Still a fourth means of entry of disease into the body is furnished by the food which is eaten. While this is not a common cause of infection, it often happens that parasites, worms, or their eggs are present in food that is a little spoiled, or that has been imperfectly cooked, or in polluted

milk, or in drinking-water. Waiters and servants who are careless in the serving of food and in the washing of dishes which they use, are responsible for considerable disease. Persons upon whose hands at mealtime are microbes that have been rubbed into the skin by the contacts of the day may thus infect their food as they eat it. Even then the individual may be in such prime condition as to destroy the parasites before harm is done. Sometimes, however, when these organisms are especially virulent, or when one's system is a trifle below par, or indeed if there chance to be wounds in the lower alimentary tract, caused by rough material in the food, or by fæces that have become hardened from constipation, the victim is at the mercy of the invaders.

Reasonably important as they are in the causation of some maladies, however, the three last sources enumerated above — wounds, bites, and infected food — are of but relatively slight significance when compared with the bacteria that attack the mucous membranes of the nose and throat.

How are parasites kept from setting up disease in the body? There are four important means by which this may be done.

1. *By keeping the general resistance high.* Of two individuals exposed to influenza, other things being equal, the one who lives hygienically, eats rationally, plays hard, works hard, sleeps soundly and regularly, and avoids excesses, will not 'take' the disease. The individual who, on the other hand, fails to pay habitual regard to these fundamental laws of healthful living will be easily attacked.

2. *By immunizing for specific disease.* We have already referred sufficiently to the importance and wisdom of vaccination and inoculation against such specific and highly dangerous disease germs as those responsible for smallpox, diphtheria, and typhoid fever. It is a mark of intelligence, as well as of good citizenship, for every healthy individual

to be immunized occasionally against diseases which can positively be controlled and prevented by these means.

3. *By avoiding those who are ill.* With the exception of physicians, nurses, and the families of those who care for the sick, persons should avoid as far as possible coming needlessly in contact with the germs of disease. Mingling carelessly with those who are thought or known to be carrying disease is to be strongly condemned in the interest of the preservation of health.

4. *By living in a sanitary environment.* Every good citizen, instead of denouncing and disparaging the annual expense of carrying on the health activities of the community, should become an ardent advocate of still more effective health supervision, and should be found always on the side of those who are striving in every community for efficient boards of health, pure water, clean streets and markets, proper sewage reduction, fly and mosquito extermination, etc. There will always be opposition enough offered to these activities through inertia and ignorance, without intelligent people being also guilty of lending it their support. The healthfulness of a community is not a goal that can be reached through negation and *laissez-faire:* it requires positive and constructive effort on the part of every responsible individual comprising the group.

Public health agencies. This latter consideration forms a logical transition point to a definite study of those agencies in a municipality which are maintained and supported either by public, private, or semi-public funds in the interest of safeguarding and promoting the health and sanitation of the community. In the following pages we shall make a brief survey of the more important of these agencies.

The board of health. The question of public health is strictly a business proposition. Public health is purchasable by the community, if the community is willing to pay the

price. Many individuals here and there, as we have said, are always ready to denounce the annual local expenditures for this purpose. These persons fail wholly, of course, to realize that money spent in guarding the public health returns a greater income in dollars and cents, not to mention increased efficiency and happiness, than almost any other item in the budget. It has been the sad experience of towns and cities that have neglected this important matter that niggardliness in the support of public health agencies is anything but economy in the end. "Any man can afford to spend two dollars," says Ritchie,[1] "if thereby he can save ten dollars, and any community that spends money on public sanitation will save far more in the extra time that would have been lost on account of sickness than it spends in trying to preserve the health of its citizens." As an illustration of the truthfulness of this opinion, Ritchie recalls that the epidemic of typhoid fever at Plymouth, Pennsylvania, cost $100,000, in addition to the $18,000 which those who succumbed to it were earning in wages per year; and that Lawrence, Massachusetts, prevented in the first four months after installing a water filter enough typhoid fever to pay the entire cost of the filter. There is undoubtedly no greater municipal extravagance than that resulting from failure to conserve the public health.

The board of health represents the embodiment of medical and sanitary knowledge in a community massed and pooled in a coöperative effort to protect the citizens from all forms of preventable disease, from whatever source it may be expected to arise. Just as the social group leaves to experts the training of its children, the care of its savings, the protection of its safety, its defense against crime, fire, etc., so it must rely upon another body to defend it from disease. This delegation of responsibility to various local boards,

[1] In *A Primer of Sanitation*, pp. 174–75.

bureaus, and departments is necessary, since it is impossible for every individual citizen to be directly responsible for the common weal. Men prefer to employ policemen, firemen, bankers, teachers, and sanitarians rather than to try to assume individual responsibility for the activities performed by these officials. In the matter of health, for example, individuals would be powerless to protect themselves from the careless, and the sick, and the dangerous; in a similar way, it requires delegated authority to install sewers, inspect food, collect garbage, construct water works, and to isolate and quarantine persons who are menaces to the general health.

The modern department of health is a far different and more complex institution than it was a generation ago. The conceptions regarding the activities of this most important of all phases of government have undergone radical changes since the days when boards of health existed on paper only, or at best came into public consciousness only when a plague broke out, or when there developed some striking nuisance in the community. Newer developments in preventive medicine, as distinct from and transcendent to corrective medicine, have been reflected in a changed emphasis upon the function of health officials and departments everywhere. The ideal of the up-to-date health officer is to prevent disease before it can develop, rather than to endeavor to check and control it after it has made its appearance. To this end, the entire health agencies of the modern progressive community are organized. Members of health departments — at least so far as the executives are concerned — are no longer prominent business men or politicians, who in times past have been very willing to grace and adorn inactive departments in the interest rather of the honor attaching to such offices or of their own political preferment, than of preserving the public health. Instead, trained medical men, capable hygienists,

and sanitarians are nowadays essential in the positions of responsibility in local departments of health, this being a peculiarly important principle of course in cities and urban communities generally, where the dwelling together of human beings in great numbers multiplies the dangers from disease and facilitates its spread. Those who are on the outposts of health in the community must be aggressive, intelligent, and scientifically informed, if they are to keep disease in large measure away from the habitations of men.

Activities of a board of health. Let us inquire what are some of the activities which progressive boards of health are endeavoring to perform in order to make possible the realization of this goal.

1. *Recording diseases and deaths.* One important duty performed by departments of health has to do with mortuary bookkeeping. In order to deal intelligently with the local health conditions, it is essential that the authorities shall know accurately what diseases are in the ascendancy as causes of death in the community, the incidence of fatalities of these diseases by ages, the wards of the city where they occur, and such other facts as need to be considered in outlining a preventive health program. If, for example, the city of X—— has a much higher death-rate from typhoid fever than other cities, or if its infantile mortality is excessive, or if relatively more cases of fatal illness from such diseases as tuberculosis, pneumonia, influenza, etc., are being reported from one part of the city than from another, the health officials know at once what and where their chief preventive efforts need to be. In many cities the mortality statistics are carefully analyzed from all angles, and published monthly by the department, so that the citizen may be at all times cognizant of the local situation.

2. *Maintaining a bacteriological laboratory.* One of the most effective means of safeguarding the health of a city is

the prompt bacteriological examination of suspected cases of contagious disease. The practicing physician has not the equipment or the time, or indeed in most cases the skill needed, to make cultural examinations of the throat of his patients. In order to assist the doctors in their diagnosis, a central, well-equipped laboratory is a modern necessity in cities of reasonable size. Localities too small to maintain such an office are compelled to depend upon those near by that do maintain them. A case in point will illustrate the importance of the service of the bacteriological department.

A physician was recently called to attend a gentleman who had been suddenly taken seriously ill. The symptoms were somewhat baffling, as they commonly are during the first few hours of many diseases, and the physician was somewhat at a loss to diagnose the trouble. As a matter of precaution, however, he swabbed the patient's throat, and on his way home left the vial at the office of the health department. Next morning his telephone bell rang early. It was a clerk in the city bacteriologist's office. The culture showed germs of diphtheria in great numbers! The physician acted promptly; knowing now definitely what ailed his patient, he proceeded at once to his home. Reaching it, he discovered that already a representative of the health department had tagged and placed the house in quarantine. The community was thus protected, and the medical man enabled to administer the proper treatment promptly and early in the development of the case. Inoculation of the members of the gentleman's family saved them also from contracting the disease. Some weeks later, after the patient had recovered, the physician took another culture of his throat, and left the swab with the bacteriologist. The report next day was negative: no bacilli of diphtheria were found present. As an added precaution, a second culture was taken, and this, too, was found negative. The patient was now entirely re-

covered from the disease, and could safely go abroad once more in the community.

3. *Inspecting stores, markets, etc.* A safe food supply offered for sale in stores, markets, etc., must be guaranteed those who patronize them. Not every dealer in foods and provisions is careful in his methods of handling food products. Careless refrigeration and dangerous exposure may combine to spoil certain foods, notably meats, poultry, fish, fruit, etc., which continue, however, to be offered for sale by the proprietor, either because he is ignorant of their condition, or because he does not want to lose on them. Products of this nature frequently become menaces to the health of those who ignorantly buy and consume them. One of the functions of the department of health is to maintain a systematic inspection service of all establishments where food is prepared, handled, or sold. Whenever and wherever spoiled products are detected, they are forthwith condemned and removed from sale. In this way, not only is a considerable amount of sickness prevented, but proprietors of food establishments are constrained to scrutinize carefully their wares and exercise continuous caution against the possibility of loss and inconvenience through the detection and condemnation of stale products by the inspectors.

4. *Maintaining a sanitary inspection service.* Not every householder or business proprietor in a city can be depended upon to be solicitous for the common welfare. There are always to be found in considerable numbers individuals who are nuisances or menaces to their neighbors by reason of their willful disregard of common principles of cleanliness and decency. Just as an indication of the number and nature of these offenders, the following table, published in the annual report of the sanitation division of a department of health in a moderate-sized city, is illuminating and interesting:

Table 18. Showing Routine Work of a Sanitary Division of a City Department of Health (1923) in Response to Complaints

Animals a nuisance	66	Filthy piazzas	23
Dead animals	8	Foul cess-pools	93
Defective catch basins	3	Foul privies	21
Defective drainage	45	Frozen fixtures	16
Defective plumbing	123	Improper rubbish receptacles	250
Defective sinks	29	Insufficient water supply	15
Defective traps	6	Leaking fixtures	12
Defective ventilation	18	No sewer connections	16
Dirty alley-ways	35	Not keeping quarantine	28
Dirty cellars	80	Odors	52
Dirty sheds	11	Poultry	120
Dirty yards	939	Stagnant water on lot	12
Filthy chutes	26	Suspicious contagious disease	5
Filthy closets	87	Throwing waste water in yard	11
Filthy dumps	64	Water shut off	61
Filthy stables	25	Wet cellars	8
Filthy stores	12		2630
Filthy garbage cans	240		
Filthy tenements	61		

In addition to the investigation of complaints, the sanitary inspection service also assumes responsibility for the periodic inspection of bakeries, bottling establishments, restaurants, boarding-houses, soda fountains, dumps, theaters, etc., and for quarantine and releasing from quarantine. All installations of new or repairs of old plumbing must also be approved by the division. These include toilets, tubs, sinks, wash-bowls, urinals, drinking-fountains, sewers, piping, etc.

5. *Milk inspection.* With the single exception of bread, milk is probably the most universal food consumed in the home. Unlike bread, however, milk cannot be produced at home, is highly perishable, and is a prime medium for the carrying of disease. For these and other reasons, one of the most important tasks incumbent upon those who protect people from disease consists in safeguarding the source of

production, the Pasteurization, and the transportation and handling of this greatest of all foods. Connected with municipal departments of health, there is a division of milk inspection whose responsibility it is to keep its fingers upon the whole milk production and distribution system as it affects the local consumption. Among the duties performed by the agents of this division are periodical inspection of farms supplying local milk, where these are at all within reach; regular inspection of milk plants where Pasteurization and bottling are done; and the frequent analysis of samples of milk taken from the vehicles of distributors. Dairies that are found to be producing milk under unsanitary conditions are denied the privilege of selling their product within the city, unless and until they improve these objectionable features. In the author's own town, for example, the supply from fifteen dairies was thus excluded in the past year. If more citizens were to make inquiry of the local health department concerning the purity and wholesomeness of the milk supplied by their dealers, they would not only thus protect themselves, but would compel careless dealers, distributing a product excessive in bacterial count, or otherwise undesirable, to raise their standards in order to meet the competition of the best and most reliable distributors.

One city department of health, commenting upon this matter, says: "Three brands of 'certified' and one of 'inspected' milk are now on sale in this city, and are guaranteed by the Medical Milk Commission as being produced under its very stringent rules and regulations. Numerous other brands labeled 'baby milk,' 'Ayrshire milk,' 'Jersey milk,' 'Grade A milk,' etc., mean in most cases absolutely nothing."

6. *Maintaining a nursing service.* Unless properly looked after by philanthropic nursing societies, there are in every

sizable community families who are in dire need of a free public nursing service. The poor, the foreign-speaking, and the unfortunate, cannot be left to themselves in times of visitation by disease and accident. The health of the entire community is in some measure dependent upon the health of those who live in the tenement districts and the foreign quarters, and society can ill-afford to neglect them when they are ill. Especially important is it that the public health department have at their disposal nurses enough to take care of this situation. The greater part of the ministration of these nurses is in homes where there are infants and pre-school children who are not receiving intelligent and healthful care.

Supervision of such homes, especially during epidemics of the common diseases of early childhood, is highly essential in the interest of checking their spread to children in other homes. Nurses brought thus in contact with very young children are often able to detect physical defects, such as adenoids, otitis, enlarged glands, etc., and recommend treatment adequate to correct them in their incipiency. The modern aggressive health department makes it a point to send a nurse into every home where an infant has been born, for the purpose of performing any needed service that the welfare of the infant or mother may demand. Treatment of the eyes to prevent *ophthalmia neonatorum*, and supervision of all cases that develop, fall within the province of the child hygiene nurse.

A similar free emergency nursing service is often needed by grown-ups who are not in circumstances where they can take proper care of themselves during illness. In such homes a daily or weekly visit of a nurse is a veritable God-send to the sufferers.

7. *Provision of school medical service.* One of the most important of all the phases of preventive work done by the

public health department is that concerned with the health supervision of the schools. While this service is in some cities under the immediate control of the department of education, rather than of health, it must be organized and maintained by the latter authority and must work in closest coöperation with it. Inasmuch as an entire later chapter is to be devoted to school health work (see Chapter XVII), we shall postpone any further consideration of the matter under this caption.

Other public health agencies. Among the other local health agencies in a community, outside of the immediate activities of the department of health, should be mentioned the hospitals, both public and private; dispensaries; baby welfare stations; milk stations; clinics; and private or semi-public nursing societies.

Hospitals are needed within a community, or easily available to it, in order to care for emergency cases, operations, accidents, and other types of serious illness which need the constant attention of a skilled nurse, or physician, or both. Many people recoil at the idea of going to a hospital; the institution exists for their use and service, however, and every one ought to be taught that a hospital is the logical and proper place to go for special needed treatment which cannot be easily or safely given in the home. Isolation hospitals for infectious diseases, such as typhoid fever and diphtheria, exist in our larger cities, as do also sanatoria for the tuberculous. Many hospitals conduct out-patient departments, where the unwell or the suffering poor in the community may apply for free treatment, without the necessity of becoming enrolled as inmates.

Dispensaries meet a similar need in cities where those who cannot afford to purchase the medicines and curatives recommended may secure them, either free of charge or at cost commensurate with their ability to pay.

Baby welfare stations are springing up in considerable numbers in congested parts of our cities, where parents are likely to need occasional advice and help in the caring for their babies. Philanthropic and public-spirited citizens in most cases are responsible for sensing the need for centers of this sort, and for promoting and in many cases supporting them. Physicians and nurses give their services gladly by turns, and are always found in attendance during certain hours. Mothers may have their babies weighed and examined, and are given expert advice concerning feeding, bathing, clothing, etc. It is no uncommon thing to find these centers fairly besieged by anxious mothers, especially during the warm months of the year.

Milk stations are similar centers, conducted for the most part during the summer months, where pure milk is supplied for babies whose mothers cannot provide it or afford to buy it. In both types of centers, lessons and demonstrations in the care and up-bringing of children are provided free of cost.

Clinics are conducted in many towns and cities for the more specific diagnosis and treatment of defects of eyes, ears, teeth, nutrition, bones, mental maladjustments, etc. Here children of either pre-school or school age may, with the consent of their parents, receive definite curative treatment for specific defects of this sort. We shall have occasion to refer more fully to the work of clinics in the later chapter devoted to health administration.

Private and semi-public nursing societies are needed in every populous community to supplement the work performed by the public nursing service. These obviously minister more typically to those who are able to pay the established fees, and hence release the public nurses from much of this work and leave them more free to devote themselves to the poor and the unfortunate.

City-wide municipal health enterprises. There are at least two major health enterprises in every community of any size which directly concern every home, business building, public building, factory, and shop every day in the year. These are a pure water supply, and an efficient system of sewage disposal. Second only to these in importance are the street-cleaning and garbage-collection enterprises. Let us study briefly the significance of these four great municipal enterprises.

Providing a continuous supply of pure water. It has been estimated that, on the average, every citizen in our large cities consumes between 100 and 250 gallons of water daily. To meet this enormous demand for the life-giving fluid, the governments of towns and cities are confronted with one of their largest problems. Not only must all these millions of gallons of water be always available, but they must be always pure and free from pathogenic bacteria. The problem raised by this necessity is a still greater one than the other. Elaborate constructions for storage, pumping, filtering, and piping become essential. Starting with the reservoir, often miles away from the city, the system spreads across mountain-sides and through basins and valleys, and then through the great pipe-lines to the city mains, which radiate underground in all directions, finally forcing surging streams of water into millions of faucets and valves in our homes and factories and schools.

As it forms in the clouds and falls downward, water is pure and clean, but as soon as it approaches the earth its pollution begins. Laden with carbon dioxide, and nitric and sulphuric acids from factories and burning coal, it falls upon the surface of the earth where in gutters, on roofs, and in filthy streets it gathers still more impurities. As if this were not enough, it is further polluted, when streams and brooks have carried it to rivers and lakes, by sewers which belch the

human wastes from great cities directly into them to mingle with it. The disease records of many cities are filled with great epidemics of typhoid fever, the bacilli of which have been thus transported by water from one individual to another. In its journey through the soil, rain water seeps gradually down into ever-deepening layers, which may be tapped or bored into from above here and there by those who are locating wells. Most of it, however, either joins with other veins proceeding through the depth of the earth, or else feeds surface streams and brooks, reaching the rivers and lakes ultimately.

Storage reservoirs. Often natural basins are dammed up by the art of man, and the waters draining into them from surrounding highlands is caught and held, subject to man's further control. These become the great reservoirs which supply our towns and cities with water. Thus, in the uplands of central Massachusetts, the great Metropolitan water works of the city of Boston are located. From the surrounding water-shed, the great reservoirs receive a never-failing flood, which is conveyed through aqueducts and gigantic mains into the metropolis fifty and more miles away. So too, far off in the Catskills are located the mighty reservoirs that supply New York City with the millions of gallons of water consumed daily. By means of natural reservoirs and aqueducts and tunnels, it is borne through the earth to the homes and tenement houses and the industries of this greatest mass of human beings to be found anywhere in the world within the limits of a single municipality. Similarly, Los Angeles, in order to insure a bountiful supply of water, tunneled through two mountain ranges and laid 130 miles of piping to reach and appropriate pure water in abundance. The supply must neither fail nor become polluted; either circumstance would produce immediately the most untold suffering and danger. Not every city is able to

pipe its water across leagues of country to its own gates, but must rely upon lakes and ponds and other bodies of water near by.

Danger of contamination. Regardless of the nearness or distance of the reservoirs, the probabilities of contamination by human wastes and sewage are very great. There is no guarantee but that the streams tumbling down the mountain-sides are receiving as they go the wash from filth, or even filth itself. Reservoirs supplied thus by streams polluted by sewage, and other organic matter that find their way into them, cannot be depended upon as safe without some kind of purification process. In general, the nearer to human habitation a water-shed is, the greater the danger from pollution and the more indispensable does proper filtering become.

Rosenau recounts the details of an epidemic of typhoid fever which was traced to a patient whose discharges were thrown out on a snow-covered hillside. The house was located some distance above the town reservoir. Shortly after the spring thaw began, three months later, an epidemic broke out in the town, and before it was checked one sixteenth of the entire population came down with typhoid. Dozens of other cases could be mentioned in which the wastes from typhoid carriers found their way either through seepage into the soil or through sewage into the water supply of other human beings, causing large numbers of cases of the disease to occur.

Purification. We may distinguish three chief methods of purification of polluted water — *storage, filtration,* and *disinfection* or *chlorination.*

In the first of these, *storage,* the water is confined in a large lake or reservoir for a period of several weeks, during which time, owing to the natural disinfecting and purifying process of the sun's rays, and the tendency of bacterial matter to sediment out, it is becoming constantly purer and

clearer. "The Mississippi River," as Broadhurst remarks,[1] "is often described as one of the best illustrations of the effects of natural aids (sunlight and oxygen) to purification, for at its mouth, after having received for 3000 miles polluting material from all of the United States which lies between the Rocky and Appalachian Mountains, it is found to be comparatively free from intestinal deposits." On the other hand, before the installation of filters and chemical treatment, Niagara Falls, sixteen miles below Buffalo, received the sewage from the latter city and had the highest typhoid rate in the United States — 133 per 100,000. There is no question but that storage reservoirs very much decrease the bacterial content, particularly if the water can remain in them for a month or more; but it is unlikely that the storage system of purification alone is entirely satisfactory and safe.

Filtration is accomplished by passing the water supply through great beds of sand, each extending sometimes over several acres. All bacterial life is caught and removed from it as the water percolates slowly down through the sand. Such filters will effectively purify the most polluted of river waters. Gradually, however, the material filtered out forms a gelatinous jacket of organic matter over the surface of the sand, thus effectually rendering it impervious to the water. This circumstance necessitates the frequent draining of the reservoir in order that this material may be scraped away, and the sand dried out and aerated. By alternating the use of storage reservoirs, they can always be kept clean.

Chlorination, or the method of disinfection, consists in treating the water supply either with liquid chlorine, or with calcium or sodium compounds known as hypochlorites. By this chemical process a large amount of water can be purified rapidly, with a very small amount of chemical. All our larger cities, including New York, Baltimore, Phila-

[1] In *Home and Community Hygiene*, p. 104.

delphia, and Chicago, employ one or another of these substances in their reservoirs.

In rural districts generally, and in small towns not supplied with municipal water works, *wells*, either dug or driven, must be relied upon largely for the water supply. The latter are usually excellent sources, since they are drilled into the earth at great depths — often fifty to one hundred feet. Bacteria that are thrown onto the surface of the ground are not found ordinarily in any great numbers below a depth of a foot or so, and are practically non-existent in soil six feet below the surface. Pathogenic bacteria do not live long in the soil, and unless they are carried in cess-pools, or in some other way are washed downward, deep-ground water is free of them. Dug wells, which are often under fifteen feet in depth, obviously must tap veins of water that drain the surface, or lie very close to it; for this reason the danger of contamination of the water in dug wells is considerable. The greatest care should be exercised in digging such wells with reference to slope, drainage from stables, privies, cess-pools, etc., in order to insure a source of water that may be trusted. The stoning-up of such wells is an important matter, particularly above, at, and just below the surface of the ground; the curb must be tight and the side-walls cemented to keep out dirt and wash from the top of the ground and the platform. Properly located and constructed, wells are as safe a source of water supply for country homes as are reservoirs for cities. Springs and brooks, however, are unsafe, for obvious reasons. Where there is any doubt as to the purity of water, it may be brought to a boil, kept boiling for sixty seconds or so, and then cooled; this treatment destroys practically all pathogenic microbes.

Disposing properly of sewage. The problems of sewage disposal and of water purification are indissolubly tied up

together, since it is pollution by sewage that in most cases infects the water supply. The city of London, in order to protect itself and its neighbors from the dangers of sewage contamination, ferries two to three millions of tons of fæcal sludge each year fifty miles out to sea. It is only when we pause to consider that on the average some 100 gallons of sewage must be disposed of per day from each individual that the proportions of this problem of the disposal of human wastes are seen in the proper perspective. Says Rosenau: "The basic principle that underlies all methods of sewage disposal is to get rid of the sewage as speedily as possible, with the least nuisance to the smallest number of people, with the least damage to health or property, and at the smallest cost."

The discharge method. The simplest method of sewage disposal in the case of towns situated on or near a stream or river is to carry the discharge sewers into the water directly. Cities located on the coast often find it satisfactory to discharge their sewage into the ocean. This method usually causes no trouble, unless the lake or stream into which the wastes are turned is too small or the amount of sewage is too great. The important thing is that the water shall not become so permeated with the waste that the amount of oxygen in the water is reduced to a point where the bacteria which work upon it cannot perform their function. If, however, there is sufficient oxygen present, the oxygen-using bacteria have no difficulty in destroying the organic matter present and changing the whole mass to an odorless liquid substance. Should the oxygen content of the water be lowered, another kind of bacteria is permitted to thrive in the sewage, causing putrefaction, with all the attendant foulness of odor. Streams thus polluted and befouled by sewage become a nuisance and a menace to all the down-river towns washed by their waters. Especially do they become a source of

danger to towns which take their drinking-water from them.

The reduction method. In order to prevent these nuisances and dangers, towns and cities not situated on the coast, or on very large rivers, usually find it necessary to make some provisions for reducing their sewage before it is discharged into streams or upon the ground. *Screening*, or passing the sewage through wire screens and thus holding back the solids while permitting the liquids and fine matter in suspension to pass through, is the simplest method. *Sedimentation*, or allowing the sewage to stand in large tanks until the solids settle, and then drawing off the top is another similar method. Often precipitation is hastened by the addition of cheap chemicals. Both these methods, however, leave behind the sludge, which may amount to 200 barrels a day in towns of 5000 population. This must be buried, spread upon the earth, or else dumped far out at sea. Nor do these methods disinfect and purify the sludge, and there is always the danger that pathogenic germs may remain in it.

Purification of sewage through some form of filtering therefore becomes necessary for most populous communities. The filter areas consist of huge beds of coarse sand and broken stone into which crude sewage is turned directly from the city sewers. Since the filters are very porous, plenty of oxygen can penetrate them and support the bacterial life that swarms in them. So efficient is the action of these micro-organisms upon the sewage that the liquid trickling through at the bottom of the beds is clear, odorless, and bacteria free. Indeed, officials sometimes drink it as a demonstration of its purity. To provide for frequent and complete aeration these coarse-stone filters are commonly used in alternation, one lying idle and open to the complete penetration of air while another is being used. In some cities the sewage is turned into a network of pipes having

numerous holes in them, through which the sewage spurts up and falls in sprays upon the beds. This process thoroughly mixes the material with the air before it comes in contact with the oxidizing bacteria swarming among the coarse stones, thus rendering the process of bacterial action more efficient, and eliminating the necessity of several hours of daily inactivity of a bed while it is being aerated. In the Columbus, Ohio, sewage treatment works, the filters cover an area of ten acres, and are filled with broken limestone one to three inches in size, and five and one half feet deep. There are 210 sprinkling nozzles per acre.

Somewhat recently a new way has been devised for mixing sewage with oxygen in order to facilitate its purification by oxygen-using bacteria. This consists of collecting the sewage into huge tanks into which compressed air is constantly pumped. Broadhurst says,[1] in commenting on these 'activated sludge tanks':

> Large amounts of air can be forced through the sewage, and very rapid oxidation takes place. Small particles of suspended matter in the sewage become covered with a slimy bacterial coating, and these are kept in constant movement through the sewage by the rising bubbles of air. When the liquid is allowed to run off, some of the sludge is kept in the tank. This consists mainly of the bacteria-coated particles, which "activate" the new lot of sewage.

Sewage disposal in rural communities. In rural regions where there are no sewers, it becomes the responsibility of every household to dispose of its wastes in a manner that will be safe for the family and for the neighborhood. The most common practice provides a closet, with a box to receive the fæces. If the vault is fly-proof in construction, and if earth, ashes, lime, or some other deodorant is sprinkled in it daily, such privies are not a source of danger. They must of course be located in a place where there is no

[1] *Op. cit.*, p. 156–57.

likelihood of veins of water which supply wells being contaminated by their seepage. The vaults must be cleaned out frequently, and their contents buried. Putrefaction of most of the contents will have been accomplished by bacteria working within the vaults.

A substitute for the vault privies is the chemical closet. This can be placed in the house, like the toilet in the city home. The receiving can is enclosed within a box, the back of which is readily removed when it becomes necessary to empty the contents. A ventilating flue is carried through the wall or roof to the outside.

Street-cleaning and refuse-collecting. These represent two other important municipal enterprises. There are few features that commend a community more to visitors and prospective citizens than the care given to the thoroughfares. Dirty streets are not only a menace to the public health, but they are a nuisance from the viewpoint of keeping our homes clean. The greater part of the dust that is continually gathering within doors represents dirt that has been blown in or carried in from the streets outside. Frequent sweeping and flushing of main thoroughfares in warm weather, regular cleaning-out of gutters and drains at least semi-annually, and at least annual oiling, are measures greatly to be desired in the care of the streets.

Under the general heading of *refuse* we may include garbage, ashes, and rubbish, the last being comprised of tin cans, bottles, broken glass, papers, rags, old clothing, and other household wastes not carried away by the sewers. Rosenau estimates that in New York City the annual refuse per citizen amounts to approximately one ton. In small communities it is usually the responsibility of each householder to dispose of his own refuse. Much of the garbage is fed to animals; the rest must be either burned or buried. Ashes may be used as fertilizer; tins and bottles are more of

a problem, but can usually be buried in out-of-the-way places.

In larger centers of population, the health of everybody demands public removal at least of garbage, which must be collected at frequent intervals and preferably daily during the fly season. Garbage pails should be provided with tight covers, and be scalded out every week. Collecting wagons are required by statute to be covered in many cities, thus preventing the escape of objectionable odors in the streets. Various methods of ultimate disposition of garbage are in use. In some coast cities the material is dumped out at sea; in others much of it is used to fill in lowlands and marshes, etc.; in others it is used as food in community piggeries; in others it is burned in huge incinerators, the temperature within which may be as high as 2000° F.; in still other cities large reduction plants are maintained where it is dried out and freed from grease. The coarser particles, bones, etc., are then run through grinders, and the material finally resulting used in making fertilizer.

Refuse that cannot be burned or otherwise disposed of satisfactorily is commonly thrown upon 'dumps,' or used for filling purposes. Ashes and other similar refuse may be satisfactorily taken care of in this way; but if tin cans, bottles, etc., are included, excellent breeding-places for flies and mosquitoes are provided, and the whole dump is likely to be a foul place that is an eye-sore, and should be a reproach, to any respectable community. With proper precautions and with adequate supervision in dumping, there can always be a top layer of ashes, dirt, or other unobjectionable refuse placed over the objectionable material within a few hours of the time of its deposit. In this way many of the worst features of dumping tracts may be removed. Garbage should never be included in refuse deposited upon public dumps.

Flies and mosquitoes as disease carriers. Before the onslaught of many of the germ diseases man is peculiarly powerless because his enemies, as we have seen, are too small to be visible to him. But flies and mosquitoes do not fall within this category. Not only can they be seen, but with a determined campaign any community can practically rid itself of both these nuisances.

The common house fly is the greatest contaminator of human food and drink known; his hairy body fairly reeks with all sorts of infective material that he picks up in filth and dirt of every conceivable description. Laden with this, he brings into the family kitchen and dining-room, either on his feet, in his intestine, or in the material which he regurgitates from his stomach, various micro-organisms capable of producing human disease.

Typhoid fever is carried so commonly by the house fly that he has been dubbed the 'typhoid fly,' although there are other diseases, notably of the digestive tract, which he also carries. Wherever an active campaign against house flies has been undertaken, an immediate drop in infant mortality has commonly followed.

Flies breed in filth, with a special predilection for horse manure, pig sties, and uncovered human excreta. Garbage and animal or vegetable refuse are also excellent culture mediums for them. In warm weather, the eggs will hatch in half a day after they are deposited; the maggots or larvæ reach full size in five days, passing from thence into the quiet pupa stage, and emerging as fully developed flies in another five days. Ten days later the female fly begins to lay her eggs, and the life cycle has been completed.

In the interest of protecting itself against the fly nuisance and menace, every home and every community should take care to control the places where flies breed. Garbage must be promptly removed; stable manure should be treated with

lime; privy vaults should be tight, and covered at all times; no decaying vegetable or other matter should be permitted to lie abroad. If every home in the neighborhood would assume responsibility for these tasks, the fly problem would be solved. There are always certain to be a few families, however, that can never be depended upon to be careful, and hence it is usually necessary to barricade the windows and doors of our homes with screens, and thus imprison ourselves safely from the fly! Millions of dollars are spent annually in this defensive action against these pestiferous marauders, to say nothing of the other millions spent for fly-papers and poisons, etc.

The hatching of the flies' eggs may be prevented and the killing of their maggots accomplished by thoroughly mixing fly-breeding material with borax, an ounce and a half to the bushel being sufficient. The borax may be sifted on the material as each new lot is deposited in a receptacle.

A safe fly poison may be made by adding three teaspoonfuls of powdered sodium salicylate to a pint of water. If a tumbler of this solution be inverted over a piece of blotting-paper and a match or toothpick be inserted between the blotting-paper and the tumbler to admit air, the blotting-paper will be kept moist so long as any of the solution remains in the tumbler. The sprinkling of a little sugar upon the paper will serve to attract the flies to it. The sodium salicylate is absolutely harmless in any amounts in which the solution could conceivably be taken accidentally.

The mosquito. Quite unlike the fly, the mosquito breeds only in stagnant water. The eggs of the female are deposited in rafts, and swiftly hatch into the larvæ, or wrigglers, which remain attached to the surface of the water by a breathing tube through which air is drawn. The larva swims about actively in the water, passing through the pupa stage, during which the adult mosquito matures rapidly.

After about ten days the pupa splits down the back, and the full-grown mosquito emerges, ready to deposit more eggs and initiate a repetition of the life cycle.

Mosquitoes are compelled to derive most of their sustenance from the juices of plants, although when it is available they very much prefer the blood of animals, which they suck with great avidity. There are many varieties of this insect, but the one most dangerous to man is known as the *Anopheles,* for it is this variety that carries the germ of malaria. The Anopheles may be readily distinguished from the harmless types from the fact that it is particularly noiseless, has black spots on its wings, and when resting or biting its body tips at about a 45° angle, the head being inclined downward and the tail pointing upward.

The breeding places for mosquitoes of all varieties — and regardless of whether they are dangerous or not all mosquitoes are nuisances — are stagnant pools, ditches, slimy ponds, quiet brooks, marshes, etc. Here they are hatched in enormous numbers during the spring and summer. But it is not alone in sizable areas of water that they breed. Half-upturned tin cans and bottles on dumps, where a few drops of rain water can accumulate, unprotected water barrels, tanks and cisterns, sagging eaves troughs, and even shallow wells furnish excellent breeding grounds for mosquitoes.

In the interest of preventing malaria, which is spread to a well person by the bite of a mosquito that has previously bitten an infected person and become itself infected with the germs, it is necessary to destroy the hatching places of the mosquito. Wherever possible, all low land in which water collects and stands, should be drained. When this is impracticable, a little kerosene poured or sprayed upon the water will cause a film to form on the surface, thus obstructing the breathing tubes of the larvæ and killing the mosquitoes. Fishes feed naturally upon these larvæ, and a

very effective means of ridding a pond or brook of mosquitoes is to stock it with minnows or other small top-feeding fish. Many widely separated communities have succeeded in banishing all mosquitoes from their neighborhoods by determined and coöperative action along these lines, and there seems to be no reason why any community could not do likewise if it resolved to free itself of this nuisance. So long as there are two or three careless or indifferent people scattered throughout the locality, however, mosquitoes will be hatched in numbers sufficient to overrun the whole region.

Industrial hygiene. The health of the worker in our trades and industries, and in our mills and shops and factories, represents another important phase of hygiene. In many communities, managers of the leading industries are already keenly alive to the necessity for keeping their employees in as excellent condition of health as possible. They know well that the moment a worker begins to feel ill, or even to become uncomfortable in his daily task, his efficiency begins to deteriorate, his output is lessened, and his value to the industry is diminished. Thus on purely economic grounds it is good business for employers of labor to surround their helpers with the best conditions achievable in the particular occupation in which they are engaged.

There are other employers, however, who fail utterly to appreciate the direct relationship between good physical condition on the part of their employees and high rate of output. Not sensing this fact, they are content to permit their laborers to work under insanitary conditions, improperly protected against accidents, and easy preys to the various industrial diseases. They do not understand that bad air, insufficient lighting, settling dust and fumes, and other conditions attendant upon various manufacturing processes are highly dangerous to men or women compelled to work amidst them for long hours every day. It is undoubt-

edly true, of course, that it is ignorance rather than willful neglect or inhumanity that is responsible for the failure of employers of labor to safeguard the health and limbs of those who toil for them; this fact, however, does not mitigate the dangers to which the toilers are subjected.

The most dangerous as well as the most common of the industrial diseases is pulmonary tuberculosis, and the reason for its wide prevalence among industrial workers in certain trades is the fact that dangerous and irritating dust particles of steel or granite are breathed into the lungs and there produce injuries and tears upon the delicate lining. These areas afford ideal spots for tubercular germs to find an entrance and set up their ever-expanding colonies. Says Dr. Winslow:[1]

> I have a letter from an old doctor in a Massachusetts town about this disease which reads as follows:
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> "I have seen quite a number of cases of so-called grinders' consumption. The symptoms are excessive shortness of breath on slight exertion, dry cough, and great prostration. The grinders are from Polanders and Finns for the past dozen years. The disease takes hold of them more frequently, and is more rapidly fatal than among the grinders of former years and of other nationalities. When I came here 40 years ago I found the victims among the Yankees who had ground some 20 years before. Those would grind some 18 or 20 years before having to give it up. The French-Canadians were then grinding. They could work 12 to 16 years. They became frightened off, and the Swedes took up the work. They would get the disease in 8 or 10 years. Now the Finns and Polanders are at it, and they last only 3 to 5 years, and the disease is more common among them."

Besides dust in the grinding and stone-cutting trades, the Metropolitan Life Insurance Company enumerates some fifty or more occupations that are sources of much dust and grit. Among these are bone industries, mother-of-pearl

[1] In *The Health of the Worker*, Metropolitan Life Insurance Company, pp. 5–6.

manufactures, felt and mattress industries in which hair dust is considerable, boot and shoe making, textiles, engraving, jute manufactures, mining, printing, sand-blasting, weaving, etc.

To keep down the dust, many factories have installed aspirating hoods and suction fans to draw away the particles as rapidly as they are formed. Others equip their grinders and others who are compelled to work in mineral dust with respirators to strain the air they breathe. Wet grinding or grinding in oil raises no dust, as dry grinding does.

Gases and other chemical fumes in particular should be kept out of work-rooms, since they injure the membranous lining of the nose, throat, and lungs. Hoods and suction fans are efficient in removing all such gases as they are formed.

In addition to dust, gases, and fumes, many shops and factory work-rooms are overheated, and scant attention is paid to ventilation. Efficient work in a hot, stuffy shop is no more possible than it is in a hot, stuffy schoolroom or office. Overcrowding in factories is prevented by statute in many States, so that each worker may have sufficient cubic space guaranteed him to be comfortable and efficient. Poor lighting is also to be avoided, this being a frequent cause of accident in industry. Eye-strain and headache frequently develop where one must continually strain his eyes in order to see. Dirty windows and smutty walls often reduce materially the available amount of light in a work-room. Glare from open flames, furnaces, etc., is always a source of danger, and workers in trades where this is inevitable need protection with special goggles. Artificial illuminants should be properly placed so that direct glare from them cannot reach the eyes of the workers. General cleanliness and tidiness; pure, cool water in abundance; and a battery of sanitary toilets are indispensable, and the right of every one who works in a

factory, shop, or other business establishment. Easy access to the services of a physician or nurse, or both, and to some one skilled in the administration of first-aid, should be always possible.

True prosperity is built on regard for the welfare of every worker who helps in its production.

TEACHING POINTS IN THIS LESSON

1. The individual's responsibility for the common health of all.
2. Enemies, visible and invisible.
3. The scourge of disease *versus* the scourge of war.
4. Microbes, good and bad.
5. How diseases enter the body.
6. Means of keeping disease germs from invading the body.
7. Functions of the board of health.
8. The importance of hospitals to a community.
9. Baby and child welfare stations.
10. The water supply in country and city.
11. Sewage removal and purification.
12. Clean streets.
13. Garbage and refuse removal.
14. Flies and mosquitoes, two great enemies of man.
15. The health of the toiler.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Make a study of one or two of the great plagues of history, reporting your results in writing.
2. List in a column as many diseases as you can think of. In opposite parallel columns, list the name and classification of the specific microorganism causing each disease, if it has been isolated; the mortality from each; and the best known means of prevention.
3. Find and list as many advantageous actions performed by bacteria as you can find any reference to in the sources.
4. Find out the personnel of the local board of health. Secure one of its recent reports, and study the different divisions or departments which it maintains, together with the general province and jurisdiction of each.
5. Make a survey of all the infant and child-welfare agencies operating in your community. Visit one of them and make queries concerning its activities, and the extent to which parents take advantage of them.

6. Consult the local water department as to the sources whence your community supply is derived. Draw a map to indicate the location of water-sheds, reservoirs, etc.
7. Make a field trip to the local sewage purification works. If this is not feasible, study carefully the method of disposal used by your town, and calculate its efficiency.
8. Make a survey of the methods in use in your community for collection and disposal of garbage, refuse, and other wastes. How effective are they?
9. Study the preventive measures in operation in a single local industrial plant for the protection of the health and safety of the employees.

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2. Coleman, W. M. *The People's Health*, chaps. 3, 13, 14, 15, and 16.
3. Hutchinson, W. *Community Health.* (General Elementary Reference.)
4. Lee, R. I. *Health and Disease: Their Determining Factors*, chaps. 20, 21, 22, and 23.

CHAPTER XVI

SCHOOL HEALTH ADMINISTRATION

Importance of an efficient school health service. Throughout this entire volume we have been stressing the importance of safeguarding and promoting in every possible way the health of the school child. We have reserved for this final chapter the discussion of those aspects of educational hygiene that devolve primarily upon the medical inspection staff, and so are only partially within the province of the teacher. Inasmuch, however, as the teacher is the one official in the entire personnel of the school environment who is most intimately acquainted with the individual child, it is highly essential for her to understand the aims and functions of the inspectional staff in order that she may work in closest sympathy and coöperation with the health officials entrusted with the administering of the school health program in the community. Lack of understanding and sympathy between these two agencies is certain to react deleteriously upon the health and best development of the children.

After all, the teacher is an expert instructor, trained to foster the rudiments of knowledge of diverse sorts in the minds of her pupils, and to stimulate within them the growth of desirable habits and attitudes toward life. She is not a physician; she is not a nurse; she is neither trained in nor can she be expected to be responsible for the discovery of deficiencies of organism or the correction of defects. Work of this nature demands a technical skill which she is far from possessing. Only those familiar with disease and its predisposing factors and preventives can be expected to assume

charge of the administering of the health inspection service in the schoolroom.

We have referred in previous chapters frequently to the tremendous amount of physical defectiveness found everywhere among school children. Obviously undiscovered and uncorrected incipient defects of whatever sort cannot but develop sooner or later into uncorrectable defects that will greatly handicap or even destroy life itself. The very circumstance that every child in the community is compelled to go to school between the ages of six and sixteen years, or thereabouts, offers the finest opportunity for an efficient system of health administration to discover and correct all abnormalities, and to supervise the growth of children during these ten formative years of life. But the system must be an efficient one. The fact that a community designates a local physician as its 'school inspector,' with an annual stipend of fifty dollars or so, is no proof that that community either desires or proposes to have a school health service; rather such procedure would indicate that the community neither desired nor expected anything of consequence to be done along these important lines. The day is now happily past in our larger towns, and in the cities, and is slowly passing in the smaller communities as well, when such a farcical provision as this can be conceived and put into operation by an intelligent citizenry. The medical inspection system of to-day and of the future, if it is to exert any positive and lasting influence upon the lives of school children, is and must be properly manned by capable experts, assisted by efficient and enthusiastic nurses, and motivated by that same desire to serve that actuates the best of our practicing physicians and their helpers in the field of curative medicine.

The point of view of the health administrators. While imbued with the same lofty ideals of service as their associates in the curative field, however, the school health au-

thorities must proceed from a wholly different viewpoint from these. The practicing physician in the community at large is, by training and experience, a diagnoser of specific ills, and a prescriber of specific curative treatment for them. He is an experimental scientist, working primarily if not exclusively upon wrongly functioning organs or processes, with a view of determining the causes back of their malfunctioning, and removing or correcting them so far as possible. The school physician, on the other hand, while just as genuinely scientific in his work and in his methods, is concerned less with obvious deficiencies and malfunctioning of the organism, and more with the influences and factors playing upon it which are likely, if not modified, to cause it definite impairment or break-down, sometime in the near or remote future. The health administrator, in other words, while a co-laborer with the curative physician on the edifice of human health, works much nearer the foundations of the structure.

There are still unfortunately in many communities health officers who have failed utterly to catch the modern spirit and attitude of prevention in the administration of the local health service. These officials still live in a bygone generation, in which it was deemed the high privilege and function of the medical officer to check the spread of communicable disease once it had made its appearance, by quarantining houses in which it was found and by excluding from school any children who contracted it. This is quite out of tune with the modern notion, not only of preventing the appearance of communicable disease, but of preventing the development of any physical impairment or abnormality in the child. The modern school health administrator is building for the future; his predecessor failed to see beyond the narrow horizon of the present.

The scope of school health administration. From the

standpoint of the school physician and the school nurse, the scope of school health administration and inspection may be said to include routine inspection of the eyes, ears, nose, teeth, throat, neck, skin, state of nutrition, nervous system, heart, deformities, etc.; the prompt exclusion from school of all carriers of disease; the culturing of all suspicious cases; sympathetic notification of parents and follow-up work in the homes where children give evidence in the routine inspection of defective nutrition or other correctable physical defects; provision of clinics and the securing of clinical service for children when necessary; the taking of active preventive steps in the control and prevention of such controllable diseases as diphtheria, small-pox, etc.; the provision of special classes where feasible for the abnormal, the partially sighted, hard-of-hearing, malnourished, etc.; arranging for school lunches or school feeding, especially in the interest of those who are in open-air and nutrition classes; periodical sanitary inspection of the school plant and its appointments; a vigorous agitation throughout the community by means of the press, addresses, radio, bulletins, reports, etc., of the importance of health education and protection; and the keeping of careful and accurate records of all the work done in order that information may be readily available to the parent, the teacher, the principal, the superintendent, and the public generally.

With such an array of official activities as this, it can readily be seen that there is a tremendous amount of careful work that must be done by the school health officials in any sizable community if they are to accomplish the things it is intended they shall. Let us examine some of these activities a little more closely.

Routine inspection work of the school nurse and the school physician. The routine inspectional work in the schools is done by the nurses, acting with the physicians. Owing to

the fact that the former are by training competent to detect symptoms of infectious disease and physical abnormalities of a non-organic nature, they are able to do most of the routine work in the schoolrooms, leaving for the medical expert such special diagnoses as they themselves are incapable and incompetent to make. In the ideal school system, each nurse has not many more than one thousand children under her jurisdiction, although fifteen hundred can be handled fairly satisfactorily by a single nurse. It is her ambition to get around to each room as often as once a week, although in systems where there is but one nurse for several thousand children this is of course impossible. Her duty is, first, to inspect the children for signs of contagious disease. When any are found during this process who are likely to prove a source of danger and a menace to others, they are excluded by her and referred to the school physician for corroborative examination, and such disposition as he may deem expedient.

In the course of her daily rounds of inspection, the nurse comes upon those children who are undernourished, and who appear to be in need of special attention. Many such children are delegated to the open-air or other special nutritional classes, where effective efforts can be put forth to build up their physical deficiencies and so permit their speedy return to their regular classes. The nurse, also, with the help of the teacher, is brought in contact with children who have other remedial disorders, such as deficient vision, poor hearing, discharging ears, infected nasopharynx, chronic colds, head lice, skin diseases, speech impediments, and the like. To secure remedial treatment for such children becomes the nurse's immediate and persistent concern.

In many school systems the nurse weighs and measures periodically all registered children, thus obtaining definite

information concerning the feeding of the children. She can make excellent use of this knowledge later in many of the homes from which her children come. Added to all these duties are those of assisting the physician in his annual medical examinations, and in such periodic ones as are necessary, and of keeping accurate records of all of the work thus done. The nurse must also be subject to call to any building in which the principal desires her advice concerning any suspicious case that her teachers bring to her notice. The work of the school nurse, other than inspectional, will be discussed in a subsequent paragraph.

The inspectional activities of the physician are necessarily more concentrated than are those of the nurse. Barring the annual or semi-annual medical examinations which he is supposed to make of all the children, the greater part of which necessarily must be done by the nurses under his direction, the physician has time only for such professional examinations and inspections as the nurses are not permitted or competent to make. These include pulmonary, cardiac, and other organic conditions that require expert diagnosis, as well as any other cases that are referred to him by the nurse or teacher. In recent years, the conducting of the Schick test and immunization against diphtheria has occupied a large share of the time of most school physicians in the progressive communities where up-to-date preventive work is done in connection with the health of the school child. Other inspectional duties of the school physician include the general oversight of those children in the special rooms, notably the open-air and nutrition classes; the frequent inspection of all parts of the school building, and the organization and planning of the entire program of health administration. Where the systems are large enough to warrant it, that is, in every community where there are upwards of five thousand children, there ought to be a full-

time medical director, with a nurse for every fifteen hundred, and a part-time physician for each additional five thousand children.

Follow-up work. As we have already indicated, the school nurse is of very material assistance to the physician in making the routine examinations of the pupils, much of which work she can do fully as competently as he. But the chief function of the school nurse is to follow up into the homes of the children the inspectional work, with the purpose of securing remedial action. Indeed, it was largely in order to promote this vital phase of the system of school health administration that the nurse was originally added to the personnel of the school health workers. Year after year, and in city after city, previous to the nurse's advent, the same ineffective drama was reënacted. The physicians found adenoids that needed removal, teeth that needed attention, eyes that were low in vision, nutrition that was poor, etc., and promptly sent notification cards to parents, with the particular item needing attention checked, and the recommendation that corrective action be undertaken. The whole scheme misfired, however, for when the next time of inspection came around the same defects were still discovered in the same children. Again formally checked cards were dispatched to the homes — and with no better results. Actual attention to these formal notifications was paid by a very small percentage of the parents to whom they were sent — in many cases not more than one or two per cent.

It became soon apparent, therefore, that school health administration was doomed to almost complete failure unless the active and sympathetic coöperation of the homes could be enlisted. There was no virtue in entering upon the school record cards the same defects and abnormalities month after month, and year after year. Indeed there was no virtue in the health inspection system at all, save the

doubtful one of piling up a yearly mass of statistics indicating the number of children having diseased naso-pharynxes, discharging ears or deafness, defective nutrition, cardiac murmurs, etc. What was needed most urgently, if the movement of health supervision was to justify itself, was parental coöperation where parental indifference was being everywhere met. The school nurse was the very happy and effective solution.

Fully half the time of the school nurse is thus spent in going about among the homes of the children found deficient in some way or other through the routine inspectional procedure. Since she is not a physician, her visitations do not strike fear to the hearts of the parents. On the other hand, coming as a school official, interested in the welfare of the children, she is usually quite welcome, even cordially so. In the home where there is a child in need of tonsillectomy, she informs the parent of the seriousness of diseased tonsils, and urges them to secure their removal in the interest of better health and more efficient school work on the part of the child. In the home where there is a child whose nutritional needs are not being met satisfactorily, the nurse gives the mother substantial advice in the matter of food values and children's dietaries, to the end that she may more intelligently select and prepare her children's food. In homes where there are children suffering from obvious eye-strain, the nurse informs the parents of the condition and strives to stimulate them to have a competent oculist examine the eyes, and, if necessary, prescribe glasses for them. If carious or impacted teeth, or other unhealthy dental condition is revealed in the school inspection, the nurse endeavors to convince the parents of the need of treatment, and persuade them to take steps to procure it.

And so with all other types and forms of correctable defects that are revealed by the health inspections at the

school. Aware of the conditions, and of the steps that need to be taken, the nurse makes a sympathetic visit to the homes concerned, and with all the tact, persuasiveness, and earnestness at her command, she confers with the parents about their children, their ambitions for them, and their responsibility in bringing them up to be just as healthy and efficient as they can possibly be. Occasionally, it is true, notwithstanding her sincerity and diplomacy, the nurse is received coldly, listened to impatiently, and dismissed rather unceremoniously, without the accomplishment of her mission. There are always to be found homes in plenty which look upon the school purely as a place of formal instruction in the three R's, and which are needlessly stirred up and even incensed if, in the fulfillment of its proper mission, the school attempts in any way whatever to obtrude itself upon the home. There are still other homes that take it little better than an affront to be dictated to or even advised as to what is for the best interest of their children. The same parents who accept as a matter of course the advice and judgment of the school authorities concerning the kind of arithmetic and history and geography their children shall consume are at once up in arms when advised concerning the kind of food they ought to eat. The difficulty lies, of course, in a misapprehension of the meaning of teaching and of education.

The nurse and the foreign-born parent. Much of the very best follow-up work accomplished by the school nurse is done in non-American homes, and among foreign-born and foreign-speaking parents. These newer citizens, unfamiliar with the ideals and customs and ways of living of America, looked down upon, frequently imposed upon, and otherwise shabbily treated by older Americans, come soon in too many cases to develop an attitude of distrust and suspicion toward us that is very hard and often impossible to

eradicate. The single agency in our whole environment that these recently arrived immigrants find it easy to trust and respect from the very beginning is the public school. Its efforts are so obviously not directed toward capitalizing the ignorance and inexperience of the foreigner, and its ministrations are so helpful and beneficial to his children, that he develops toward it a most profound respect and trust. Is it not making over his children, still redolent of the ways and haunts of the motherland, and building them under his very eyes into real Americans? Why should he not trust and respect it?

As an agent of this same public school system, working always for them in the person of their children, the school nurse shares in the deference and appreciation which the immigrants hold for the schools, and usually succeeds without much difficulty in enlisting their enthusiastic support and coöperation in the remedial treatment which she recommends as being essential to the best success and happiness of their boys and girls. It is often little short of pathetic to mark the religious strictness with which an immigrant mother will follow the directions and suggestions of the school nurse in such matters as the dietary of her children, the care of colds, bruises, etc. A little extra persuasion and encouragement are usually needed to bring these parents to the point of agreeing to the removal of infected tonsils or adenoids, the administering of the Schick test, and the like. In most cases, however, the nurse is equal to the task, and if she cannot bring the parents round to her way of thinking during the first visit, there are other and still other visits that she will make in the near future, always with the purpose of building up increasing parental confidence in the wisdom of the school health program, and gaining fullest parental coöperation with it. The fact that foreign-speaking nurses are employed in most cities having foreign

elements, tends to make easier the development of cordial relations between parents and school. Thus, a Swedish-speaking nurse is assigned to the schools in the Swedish neighborhood, a Lithuanian-speaking nurse to those in the Lithuanian neighborhood, a Yiddish-speaking nurse to those in the Jewish neighborhood, etc. In this way there are no obstacles placed to the development of the school health program on the score of language difficulties, and the fact that it is an official from one's own racial stock who is representing the school and urging coöperative action with it, renders such action much more easy to secure.

The nurse as a teacher. In addition to her multitudinous duties in routine inspection in the schools, and subsequent follow-up work in the home, the school nurse is called upon also frequently to be a teacher and demonstrator of health and health habits to the pupils in the actual schoolroom. Some of the most effective health lessons taught are those on good and bad foods, food preparation, care of the teeth, first-aid, etc., prepared and taught by the nurse herself. Training of this sort supplements most excellently the hygiene lessons taught by the classroom teacher, introducing variety and added interest into the general subject of hygiene. Whenever possible, the nurse accompanies and illumines her lessons with actual demonstrations. Thus, well-balanced menus are planned and actually prepared and served occasionally under her direction; tooth-brush drills are given frequently; and whenever there is first-aid treatment to be administered to a cut, or bruise, she finds in that situation excellent opportunity to teach a general lesson on cleanliness, disinfection, and care of wounds of all sorts. Instruction of this kind given by a nurse in uniform cannot but impress young people with the importance of the whole subject of health and cleanliness.

Illustrative of the important rôle played by the school

nurse in up-to-date school health departments of the present day is the following excerpt, describing the work of the nurses in the schools of Syracuse, New York.[1]

Once each week throughout the school year, all pupils are inspected by the school nurses for signs of contagious diseases. Children whose condition indicates that they may prove a menace to others are excluded from the school. The nurses' duties include also the weighing and measuring of all children enrolled. Those who are ten per cent or more underweight are reweighed at frequent intervals. Milk and crackers are provided for selected children through a voluntary agency coöperating in the demonstration.

The eighteen school nurses assist in selecting the children who attend the five open-air schools. They help also in selecting children to be placed in the sight-conservation classes; the nutrition classes; the classes for stutterers and for pupils with defective speech; and in the three opportunity classes conducted for children who are mentally retarded.

By personal contact with the pupils and their parents (i.e., follow-up work), the nurses have also rendered valuable service in the correction of physical defects of school children. A summary of their reports indicates that in 1924 such defects were adjudged to have been corrected in 7340 instances. These included 659 cases of tonsillectomies and adenectomies; 1192 of defective vision, and 3863 of defective teeth.

Training and qualifications of the school nurse. It is obvious that in order to succeed in influencing parents to act upon her suggestions and the recommendations of the school health officials, the school nurse must be a woman with boundless tact and common-sense. About the easiest way in the world to antagonize a parent is to inform him that he is not taking proper care of his child's health, and a nurse who went at the matter bluntly and without proper discretion would do much more harm than good. An immense amount of patience, sympathy, forbearance and diplomacy

[1] From the *Quarterly Bulletin* of the Milbank Memorial Fund, vol. 3, no. 2, July, 1925.

is essential to this work. The nurse must understand the viewpoint of the home and its natural aloofness to outside interference, however unselfish, in its family affairs. Her touch upon it must be at once delicate and firm. A good deal of self-discipline and self-control will be needed in many a home where downright discourtesy and unfriendliness are manifested. Yet knowing that what she is proposing is for the best good of the child, the nurse must compel herself to disregard such rebuff and obstinacy, and drive with determination toward her goal.

The school nurse must also be a person who herself enjoys excellent health and takes the best of care of it. An unhealthy nurse is an individual quite out of place and in a wholly wrong calling. The ideal school nurse is well-mannered, polite, neat in her personal appearance, and possessed of a high capacity for work. A believer in and a lover of childhood, she should be always a welcome and anticipated guest in the schoolroom, approachable by the pupils, and interested in their problems and general welfare. Temperamentally buoyant and happy, she ought to radiate sympathy and good cheer everywhere. Accuracy and conciseness in her work; promptness in responding to summons or to directions from her superiors; neatness and methodicity in keeping her records; order or system in following her schedule or program; and an unwavering conviction of the high importance of the services she renders to the building of childhood — these are additional ear-marks of the successful school nurse.

Quite apart from these qualities of character and disposition, the professional training of the school nurse for her work is of prime importance to successful achievement in the field of school health supervision. On the medical side, while of course not a physician, she should have had at least a year's experience in a children's hospital, or in the chil-

dren's ward of a general hospital, serving in the capacity either of a student nurse or a graduate nurse. In this way she will have been brought into contact with all manner of children's diseases and defects, and will have gained first-hand observational experience in the recognition of symptoms of various ills and abnormalities of childhood.

In the training school the nurse will have had first-class courses in child hygiene, infant welfare, personal and community hygiene and sanitation, school hygiene, dietetics, and physical education. She should also have had full courses in child and educational psychology, in addition to such non-professional but liberalizing studies as are included in the curricula of all secondary and higher schools.

Training and qualifications of the school physician. Of equal importance with the qualifications of the nurse are those of the school physician. Inasmuch as most school physicians devote the major part of their time to their own private practice, working in the schools only a few hours per week, it is impossible to demand in their training exclusive attention to the diseases and the hygiene of childhood. Notwithstanding this circumstance, however, the chief inspector or other supervisory official should insist so far as possible upon employing as part-time school physicians only those men who have taken in the medical school special courses in children's diseases and welfare. Conspicuous local success in the knowledge and treatment of children might be deemed the equivalent of such training in the medical school. Specific training or experience in the ministering to children cannot be too urgently insisted upon in the selection of the school physician, since most medical students are in training for general practice, and almost inevitably their studies and observations have a decidedly adult slant and stamp which fit them but poorly for work with children. Some medical schools are now offering complete courses of

training for service in the schools, and young men so trained are obviously greatly to be desired sooner or later as school physicians; most medical schools at least offer elective courses in child care and treatment, and physicians who have elected these should be given preference, other things being equal, over those who have not had such training.

One often hears it urged that the school doctors are usually young men, but recently out of medical school, and eager to accept a position on the inspectional staff as a 'pot-boiler,' while they are slowly building up their own private clientele. The inference is, of course, that because of their inexperience, young medical graduates are not to be desired as school physicians. Such an attitude is quite wrong, if only because what they may lack in breadth of experience these young physicians invariably make up for in enthusiasm and earnestness of purpose. The writer has known many a mature physician of wide experience who grumbled about the hour a day he was supposed to spend in the schools, pronounced the whole thing to be farcical, and brought neither sincerity nor the spirit of service to his work with the children. Far better to trust this important work to the young enthusiast than to the elderly cynic.

But there is a greater reason than this why the recent graduate of the medical school is not merely as desirable as, but may actually be preferable to, the older physician. That reason lies in the fact that by virtue of the recency of his training, the former is likely to be more up-to-date in his viewpoint and more modern in his methods than the latter. There is grave danger that occasionally older men who seek employment as school physicians have not kept up with the march of medical progress, find their clientele dwindling, and are thus prompted to seek or accept public employment. This statement of actual truth is not intended in any way to minimize or disparage the faithful work of thousands of ma-

ture school physicians whose clientele grows larger year by year as their repute spreads, and who sacrifice much for little pay to serve the children in the schools. Every one who is at all familiar with the situation is aware of this fact, and of the heroic service rendered by these men. The circumstance is pointed out merely as an indication that youthfulness is no less desirable because of youthfulness than is maturity because of maturity. It is not age, but fitness and point of view that should be weighed in the balance in the selection of school physicians.

In addition to their formal training, with children at least as prominent as adults in the professional courses pursued, physicians who serve the schools should have had courses in psychology and in the supervision and administration of *health programs.* Throughout, as in the case of all workers with children, the emphasis in their training should be primarily upon the side of prevention, with correction and treatment occupying a distinctly subordinate, though by no means neglected, place. Other qualities which should be achieved through training or cultivated as a part of native endowment by those who would become school medical men include a liking for children, a sympathetic nature, cheerfulness, professional thoroughness and exactitude, a pleasing personality, tact, energy, and a high sense of duty, responsibility, and service.

The school clinic. For the great mass of parents the cost of adequate health supervision for their children by the private physician, the dentist, and other specialists in the health field is prohibitive. The result of the high cost of health is, in millions of homes, the neglect of health except in cases of actual illness, when the aid of the expert cannot be dispensed with. Incipient defects, however, and lesser ailments, such as carious teeth, diseased tonsils and adenoids, otorrhœa, osseous deformities and abnormalities, eye-strain

and poor vision, are likely to be completely disregarded as relatively unimportant to the health and welfare of the child. Yet the modern ideal of preventive hygiene is to discover such defects as these early in their development, and correct them before permanent injury is done the organism of the growing child. With the best intentions in the world, an inspectional staff may detect the abnormalities, besiege the home for corrective treatment of them, and yet experience defeat in securing the action desired for the good and sufficient reason that parents cannot afford to pay the fees collected by private practitioners.

It is apparent then that any system of school health supervision is doomed to failure which does not provide, along with health inspection, adequate means for the treatment and correction of defects found, either free of charge or else at a very nominal cost to the poorer parents. Such means have been provided in great numbers of cities and towns, where the community is fully alive to the needs of the children, in the establishment of school clinics. In some localities a single building houses these clinics; in others, they are scattered over the city at various points; for example, in the hospitals, at the dispensaries, in schoolhouses, and in board of health and educational administration buildings.

School clinics include dental clinics, where pulling, straightening, extracting, cleaning, and prophylaxis are performed by skilled dentists; eye clinics, where examinations are made, prescriptions written, and glasses actually provided at a minimal cost; ear clinics, where examinations are made, wax removed, ionisation and drainage performed, and discharging ears sterilized and treated; nose and throat clinics, where tonsillectomy and adenectomy are performed; cardiac clinics, where children with heart involvement may receive expert advice and treatment; orthopedic clinics, where twisted and bent or otherwise deformed bones of

back, hip, and limbs are given every stimulus to normal growth and development; speech clinics, where children with structural irregularities of the speech organs, or with merely functional disturbances, are helped in the establishment of proper control over the oral mechanism; and a few other clinics of a specialized nature, such as nutritional clinics, habit clinics, etc.

Not every community, obviously, maintains all types of clinics. Those most commonly found are dental clinics, and these exist in most cities of moderate size. They are also made available in many rural communities as traveling health units sent out by the Red Cross, or the Department of Health, or by some other agency interested in promoting the health of the school child, and reaching sooner or later every township in the county.

Boston and Rochester are two cities notably well equipped for dental prophylaxis among school children, the former through the Forsyth Dental Infirmary, established and endowed by the Forsyth brothers; and the latter through the Rochester Dental Dispensary, founded and endowed by Mr. Eastman.

The Forsyth Dental Clinic in Boston. The Forsyth Infirmary holds the viewpoint, as expressed by Dr. Cross, the Director,[1] that "to accomplish the greatest good it is necessary to aim at something more than the mere repair and treatment of carious teeth and other mouth defects." Starting out originally on the basis that prevention is the important note in dental hygiene, this institution has consistently aimed to conduct its activities in such a way that it would be of the largest service to the rising generation of children of the city of Boston and vicinity. Year by year it has striven, through the coöperation of school physicians,

[1] See *Proceedings* of the Thirteenth Congress of the American School Hygiene Association, New York City, 1921, p. 52 ff.

nurses, and teachers, to reach down farther and farther into the grades, and even to the kindergarten and pre-school child, in the interest of dental hygiene and care. That its efforts have been successful is indicated by the fact that, while in the first six months of its existence the average age of those children who sought its ministrations was fourteen years, the average in 1921 was six years, since which time efforts have been successful in reaching the 8000 kindergarten children in the city of Boston. Children from the schools are escorted to the infirmary by the school nurse in groups of ten to fifteen, coming in special cars or busses. Each nurse further coöperates to the extent of having a specified number of children present at definite times. Charitable societies, private schools, and other institutions are accorded the same privilege as are the public schools. There is no restriction as to race, creed, or color, the only prerequisite for admission being possession of a toothbrush, which is either purchased by the child or supplied gratuitously.

Table 19 indicates the rate at which the percentage of dental defects is decreasing in the Boston public schools, largely through the service of the Forsyth Dental Infirmary to the community.

TABLE 19. COMPARATIVE RECORD OF DENTAL DEFECTS IN THE BOSTON PUBLIC SCHOOLS FOR A FIVE-YEAR PERIOD

	1916	1917	1918	1919	1920
GRADE V					
No. examined	10569	10535	9452	9831	9679
Defective	54%	48%	47%	42%	42%
GRADE VI					
No. examined	9419	9388	9797	9435	9536
Defective	46%	45%	40%	30%	35%

The Rochester Dental Dispensary. A feature of the work in the Rochester Dental Dispensary, in addition to the treatment of the teeth of the local children, has been the

extension of dental service to the entire school population of Monroe County. Squads of dental hygienists are sent out into the various towns, where prophylactic treatment is given, and where those needing attention at the dispensary are discovered. During the first year in which the extension service was made available, 3500 children outside of Rochester had their teeth cleaned, and some 500 additional were brought by the nurses into the city for special treatment at the institution.

The moderate per-capita cost of clinical work is thus commented upon by Dr. Burkhart, Director of the Dispensary:[1]

> In 1918 it cost approximately $1.08 and in 1919 $1.27 a visit. Operations cost at the rate of 44 cents per operation in 1918 and 54 cents in 1919. These figures include the cost for upkeep and overhead. Further analyzing the cost of the work in the various departments it is found that in the dental department the expense is 22 cents per operation, in the extracting department, 23 cents, in the orthodontia department 97 cents, and in the hospital for tonsil and adenoid work $16.00. It may be said in explanation of the last two items that as these departments are just getting under way, the expense will be reduced during the year. The expenditure of the Dispensary last year, other than the doing of the prophylactic work in the public schools, amounted to something over $64,000. These figures are mentioned for the purpose of calling to mind the large amount of money which is expended, through the generosity of Mr. Eastman and the Board of Directors, for the benefit of the children of Rochester.

The following summary of the activities at the Rochester institution for a single year (1919) is interesting as indicating the wide range of prophylactic work done by a well-equipped and endowed dental clinic:

> Tooth treatments, 46,521; root treatments, 19,593; root fillings, 1523; cement fillings, 15,268; gutta-percha fillings, 142; silver

[1] In the *Proceedings* of the Twelfth Congress of the American School Hygiene Association, Cleveland, 1920, pp. 48–49.

nitrate, 174; pulps capped, 77; crowns, 31; inlays, 3; orthodontia treatments, 4117; prophylactic treatments (orthodontia), 150; devitilizations, 635; extractions, 11,977; X-rays, 351; visits to dispensary, 48,813; patients paid 5 cents, 42,994; dismissals, 10,260; prophylactic treatments in the schools, 66,953; lectured to in the schools, 38,411; surgical department examinations, 227; adenoid and tonsil operations, 125.

Large-scale dental infirmaries and dispensaries, like the Forsyth and the Rochester institutions, do not limit the range of their activities to the care of teeth, but include also facilities for general oral hygiene, a feature of which is the removal of tonsils and adenoids. Thus, in the Rochester Dispensary during fourteen weeks in 1921, when a special intensive attempt was made by the staff to clean up as many of these cases as possible, 8589 operations were performed for the removal of tonsils or adenoids, only urgent cases being done during that time.

Unfortunately, however, not every community has the advantages offered by an endowed clinic; most cities and towns must rely upon their own unaided efforts to provide reasonable clinical facilities to care for the needs of those children who would not otherwise secure expert attention to their physical impairments and deficiencies. In many communities, public-spirited citizens and organizations, like the Red Cross, the Public Education Association, the Chamber of Commerce, the Rotary and Kiwanis Clubs, etc., take the initiative in this connection, to the extent at least of interesting local dentists, physicians, and surgeons in the problem. In still other communities, it is the medical and dental men themselves who first sense the need of clinical service, and who take steps to provide it. In either case, obviously, it is the professional men who must do the work, once a clinic has been established. By alternating around the list of members, a local dental society in any sizable

town can usually so apportion the responsibility that it falls upon any one man only occasionally to spend an hour, or two hours, or perhaps an afternoon, at the clinic. Most dentists and physicians are glad to serve thus the poorer children of their community without recompense. Frequently, of course, funds are made available by philanthropic societies or individuals for remunerating those who give of themselves in this altruistic work. As a rule, however, at least during the first year or so of the existence of the school dental or other clinics, little money save that subscribed by the profession or by public generosity for equipment and supplies is available, and the brunt of the endeavor falls upon those who perform the work. Gradually, however, as the community is educated up to the point where it can appreciate and understand the importance of free clinical provisions for the poorer children, it takes over the work thus begun as a philanthropic enterprise. In this way many a city now proudly boasts the possession of clinics of various types among its agencies and instruments of public education.

Rural clinics. By reason of their isolation and the sparseness of the school population, rural communities naturally find it a considerably greater problem to provide clinical facilities for their children than do the larger centers. The expense to a small village of the equipment and maintenance of even a single clinic is prohibitive. Consequently some form of coöperation between all the schools of a rural county or district must be arranged whereby the cost for each is greatly reduced. This has been accomplished most economically and successfully by means of the traveling dispensary or the ambulance clinic, which tours up and down through a given region, reaching sooner or later in the course of a season every school within the territory.

The following interesting account of the dental ambulance

in Nassau County, New York,[1] is typical of the service rendered country children by traveling health units of this sort. In this particular case the expenses incurred were underwritten by the county chapter of the Junior Red Cross to the extent of $15,000.00.

The schools of Nassau County, New York, with the assistance of a Red Cross organization, are doing successfully a most important pioneer work in the matter of health education, a work fast producing results pointing out the way to the solution of that not easy problem, the administration of health supervision in the schools of villages and rural communities. Efforts on the part of the school authorities, therefore, to get defects corrected were sometimes met by direct refusals from the parents, and oftener checked by the realization that pupils traveling to the dentist or physician lost too much valuable time during school hours. There seemed to be an eager desire on the part of both the American and foreign parent to provide their children with this necessary relief when these matters were brought to their attention and carefully explained, but there was a lack of opportunity. Moreover, complaints came from fathers of large families that they could not meet the expense of having work done in private practice. . . .

In doing this important work, we hoped to wipe out any existing indifference on the part of local school authorities regarding the necessity of providing medical or surgical relief or treatment for school children. By means of illustrated lectures and printed matter we believed we could educate both children and parents concerning the importance or remedial care of all children suffering from disease or physical defect. Finally, we would be furnishing opportunities to give to school children this relief and treatment, as required by law, at a minimum expenditure of money, time, and effort on the part of the children, parents, and school authorities.

Fortunately, for $750 we were able to secure from the New York State Dental Society a dental ambulance intended for overseas service, which had failed of transfer before the signing of the armistice. The remainder of the equipment for a dispensary consists of an Archer Prophylactic chair, foot engine, instrument case, instruments, sterilizer, and the necessary expendables to do the type of

[1] By Walter J. Muller, in the *Proceedings* of the Twelfth Congress of the American School Hygiene Association, Cleveland, 1920.

work planned. One Waug X-Ray machine centrally located meets the needs of all the schools. The list prices charged for these articles are as follows:

Archer Prophylactic Chair	$ 80.00
Foot Engine, complete	41.00
Instrument Case	11.00
Sterilizer	14.00
Expendables	87.00
Non-Expendables	130.00
Total	$363.00

The first dental dispensary began operations on September 8, 1919, in the public schools of Roslyn, New York, where with endorsement of the school authorities it immediately became popular with both parent and children. This dispensary was an experimental one. Thoughtful attention was given to the collection of data regarding the time required to perform the various operations and all the expenses necessarily incurred, so that we could establish prices which would bring a return fully covering the expense of operation. After experimenting for some time, we find that dental service can be rendered at a cost charge which almost every parent can afford.

It must be understood that the Junior Red Cross is not dispensing charity, except in a few isolated cases, where with the approval of the school authorities, inquiry as to the conditions in the home has produced facts which warrant our doing the work at less than cost. It is generally accepted that, where the per-capita income of a family is at least six dollars a week, the full charge shall be paid. The poor people of to-day are not all poor because of lack of money; some are poor on account of a lack of knowledge of the use of money.

The first dispensary received much local approval and commendation. Tidings of its accomplishments and success spread so rapidly and applications for service received from schools were so numerous, that it became necessary to secure at once additional dentists and equipment to meet the demand. On the average we have added one dentist a month until we now have five.

Whenever application for dental service is made by a principal or superintendent, a dispensary is assigned to the school for a length of time proportionate to the number of children attending, or the approximate number of children who are to receive dental service. On the first day, upon the arrival of the car, the equipment is re-

moved from the car to some convenient room in the school building which is to be used for the dispensary. The dentist in charge spends the greater part of the first day making examinations of the children's teeth, usually with the assistance of a nurse; mouth charts are made in duplicate which show exactly what work should be done and what the cost charge would be for putting the child's mouth into healthy condition. A combination notice and consent card is filled out and sent to the parent together with a copy of the mouth chart. If the parent desires to have the child receive the benefit of this service, he signs the consent card and returns it to the school, and an appointment is made. In nearly every case the parents have been so eager to take advantage of this opportunity that they are willing to pay the cost charges in advance.

We believe that the educational feature of our project is becoming by far the most important. The subject of oral hygiene causes us at once to think of a dental dispensary. The dispensary is essential, but it must have associated with it an educational effort. This effort should teach the child that decayed teeth and injury to the gums are preventable, and cause him to receive proper instruction in the care of the mouth.

Soon after a dispensary is opened in a school, an illustrated talk is given to the school children upon the subject of oral hygiene. In some of the larger villages this talk is given in the evening to adults. In order to reach the homes through the children, a series of blotters has been prepared, giving such information relative to the care of the teeth as adults and children should know. We have found that in too many instances pamphlets and circulars containing this information have been thrown into the streets by the children, but when this information is placed upon some useful article, such as a blotter, the child takes it home. In a further effort to keep the importance of having clean teeth before the minds of the pupils, each pupil patient receives a button, upon the completion of his work, which he proudly displays to his fellow pupils. This button bears the slogan: "Clean teeth in Nassau County."

Needless to say, the dentists in the villages where we have operated have loyally supported us, and they say that the mere presence of the dental education car in front of the school building has a surprising educational value. Since the dental display has come into my own school system, I have daily excused from school to receive dental treatment ten times as many pupils as before.

Between September 8, 1919, and February 1, 1920, there have been placed in operation five mobile dental dispensaries, having an

average operating period of 14 weeks and 2 days each. A fair measure of the relief which may be rendered in rural communities in such dispensaries may be taken from a consideration of the following summary of the reports of the dispensaries during the past month of January, the only calendar month in which all the dispensaries were in operation for an uninterrupted period of four weeks:

In approximately 468 hours 322 children received dental relief, requiring 605 sittings; from the mouths of these children were extracted 142 first or six-year molars, and 150 other teeth, which were mostly deciduous teeth. Eleven hundred and twenty-one cavities were filled, and the teeth of 219 received prophylactic treatment. The roots of 16 six-year molars were filled, requiring 219 treatments. A total of 1750 corrections were made, which is an average of over 5 corrections for each child. An average charge of 69 cents has been made for each correction, or an average charge of $3.73 to make all the necessary corrections in the average child's mouth. The total charge for the work done was $1202.70, which has more than paid the operating expenses of the five dispensaries for that month.

The control of school health administration. Without any question, the vesting of the control of and responsibility for school health administration in the hands either of the public health or the educational authorities should be determined by expediency and by the local situation. The important thing in the conservation of the health and physical efficiency of the child is not what agency is responsible for it, but rather that effective work shall be accomplished.

In the heat of the sometimes acrimonious discussion as to whether the administration of school health work should properly be in the hands of the health department or of the school department, or be jointly performed by both, the real issue is too often lost sight of. It can make no possible difference to the ailing or needy child who shall be charged with the oversight of his health, and the correction of any deficiencies with which he may be afflicted; that the best possible care shall be taken of him, he has a right to expect.

Society can ill afford wasting time in futile discussions as to who shall be permitted to assume this responsibility. The urgent and indispensable thing is that efficient work shall be done, and if one agency proves itself incompetent, then by all means let the duties be delegated to some other that can be relied upon to perform it with sympathy, aggressiveness, and success.

TOPICS FOR SPECIAL STUDY AND REPORT

1. Consult some school nurse — preferably one of your own acquaintance — and ask her to give you a somewhat detailed account of a typical day's work in her department. Question her especially about her follow-up work and the results she is able to achieve in the homes.
2. Study the school health program in operation in your own city, with the purpose of reaching a conclusion as to whether it is actuated by the progressive ideals suggested in this lesson, or whether it appears to be little more than a perfunctory attempt to control contagious disease, prevent epidemics, etc.
3. If a given community can afford but one school health worker, which would you recommend, a school physician or a school nurse? Support your contention with several reasons.
4. Find out: (1) how many registered school children there are in your community; (2) how many school physicians and school nurses there are; and (3) the salaries they receive. Are any of them part-time workers? Does it seem to you that there is an adequate number of workers to properly care for the health of the school population?
5. Inform yourself as to the number and nature of the available school clinics in your city. Appoint a delegation from the class to attend each clinic for the purposes of securing information and impressions concerning the work being done. How is each clinic financed?
6. Look up the laws of your State with reference to the health inspection of schools, the means of control established, and such other legislation as bears upon the subject matter of this chapter.

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